

Taxonomic studies in the genus *Haplanthodes* (Acanthaceae)

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
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Abstract

The endemic Indian genus *Haplanthodes* (Acanthaceae) is revised. Four species, viz. *H. neilgherryensis*, *H. plumosa*, *H. tentaculata* and *H. verticillata* and a new variety, *H. neilgherryensis* var. *toranganensis* are recognized. Lectotype is designated for *Haplanthodes*, *Haplanthus plumosus* and *H. verticillaris*. The nomenclature of the Linnaean name *Ruellia tentaculata* is also discussed. Micromorphology of seed using light microscope (LM) and scanning electron microscope (SEM) is observed for the first time, and two types, reticulate and micro papillate, have been recognized based on surface sculpturing pattern. The genus differs from the related genera *Andrographis* and *Haplanthus* by distinctly two grooved seeds with hygroscopic hairs. Pollen grains of the genus are oblate or prolate spheroidal, distinctly triangular, trizonocolporate with reticulate exine ornamentation.

Keywords: Endemic, peninsular India, pollen, seed, SEM, typification, Eudicots

Introduction

The genus *Haplanthodes* Kuntze (1903: 265) (Acanthaceae) was proposed to replace the name *Haplanthus* T.Anderson (1867: 503) which was a later homonym of *Haplanthus* Nees (1832: 77). In fact, Anderson (1867) synonymized the type of *Haplanthus* Nees, i.e. *H. tener* Nees (1832: 116) to *Andrographis tenuiflora* Anderson (1867: 502) and a new generic name was therefore necessary to encompass the species added by Anderson (1867). *Haplanthodes* belongs to tribe Andrographideae in subfamily Acanthoideae together with *Andrographis* Nees (1832: 116), *Gymnostachyum* Nees (1832: 76), *Diotacanthus* Benth (1876: 1100), *Graphandra* Imlay (1939: 126), *Haplanthus* Nees and *Phlogacanthus* Nees (1832: 76). *Cystacanthus* T.Anderson (1867: 457) was merged with *Phlogacanthus* based on molecular data (McDade *et al.* 2008; Surveswaran *et al.* 2020). It can be easily identified by its spiny, hairy cladodes; axillary, solitary flowers, hygroscopic hairy, distinctly two grooved, 6–8 seeds per capsule. *Haplanthodes* is closely related to *Andrographis* and *Haplanthus* Nees. It differs from *Andrographis* in having cladodes, included stamens, oblate pollen grains and sub-actinomorphic (5-lobed) corolla. It differs from *Haplanthus* in having corolla 5–6 mm long vs. 8–12 mm long, 3–4 ovules per locule vs. 6–8 ovules per locule, 6–8 hygroscopic, distinctly two grooved seeds vs. 8–16 non hygroscopic, not distinctly grooved seeds (Gnanasekaran *et al.* 2016). *Haplanthodes* is a small genus endemic to India and comprises four species with the maximum representation (3 species) in the peninsular states (Panigrahi & Das 1981), viz. *H. neilgherryensis* (Wight 1850: 7) Majumdar (1971: 76), *H. plumosa* (Anderson 1867: 504) Panigrahi & Das (1981: 200), *H. tentaculata* (Linnaeus 1756: 22) Majumdar (1971: 76) and *H. verticillata* (Roxburgh 1820: 135) Majumdar (1971: 76). In the work of Panigrahi and Das (1981), they did not typify the names, *Haplanthodes*, *Haplanthus plumosus* and *H. verticillaris*. Also, the micromorphology of pollen or seeds has not yet been observed.

In the present work, we revisit the taxonomy of the genus with a view to provide additional characters for species

delimitation. We studied the micromorphology of seed and pollen through scanning electron microscopy. Additionally, a new variety, *H. neilgherryensis* var. *toranganensis*, is described in this study. All the taxa have been illustrated and their ecology and geographical distribution are also discussed. Also, a polythetic key is provided for identification of the taxa.

Materials and methods

Taxonomy

Plants used for study were collected from different localities. Additionally, the herbarium specimens from BLAT, BSI, CAL, MH and SUK were examined. Specimens housed at GZU, K, L, LINN, P and S were examined online (herbarium codes follow Thiers 2020). Identity of the specimens was confirmed by referring to the floras of India (Clarke 1885, Cooke 1908, Singh *et al.* 2001). Illustrations were prepared based on the live plants and herbarium specimens. Morphological investigations of all the taxa were done by dissecting the fresh material. The voucher specimens are deposited in the herbarium of the Department of Botany, Shivaji University, Kolhapur (SUK).

The data on localities of taxa were studied based on field collection and herbarium consultation. All the plants collected from field were GPS marked (Garmin GPSMAP 62s). The blank maps were made by using DIVA-GIS software (Hijmans *et al.* 2001). The legends, symbols were added in map and photo plates for all taxa were made using Adobe Photoshop 7.0.

Palynology

Pollen grains fixed in glacial acetic acid were acetolysed (in freshly prepared 9:1 acetic anhydride: concentrated sulfuric acid) following the technique of Erdtman (1960). Acetolysed pollens were observed and photographed under Leica DM 2000 fluorescence microscope. For scanning electron micrographs, pollens were mounted on a double-sided sticky carbon tape bound to an aluminum stub, then coated with gold/palladium for 75 s on a Quorum SC7620 sputter coater and examined using a TESCAN VEGA3 scanning electron microscope (SEM) at 10 and 15 kV. The pollen grain measurements were made from semi-permanent preparation of acetolysed pollen grains mounted in glycerin jelly. Measurements for at least twenty pollen grains for each taxa were taken and mean with standard deviation is presented. The value of P (Polar axis length) and E (Equatorial diameter) were calculated to find out P/E ratio. The terminology follows Punt *et al.* (1994).

Seed micromorphology

Seeds of each taxon were photographed under a stereomicroscope (Labomed CMZ6, India) at 10 X magnification and observations were made on seed size, shape, color and ornamentation. For SEM studies, seeds were coated with gold/palladium for 75 s on a Quorum SC7620 sputter coater and examined under TESCAN VEGA3 scanning electron microscope at 5 kV and 10 kV. The terminology follows Barthlott (1981).

Results

Taxonomic treatment

***Haplanthodes* Kuntze (1903: 265).** \equiv *Haplanthus* T.Anderson (1867: 503). **Type:**—(lectotype designated here) *Haplanthodes plumosa* (T.Anderson) Panigrahi & G.C.Das (\equiv *Haplanthus plumosus* T.Anderson).

Herbs. Stems quadrangular, pubescent; hairs dimorphic; unicellular eglandular, multicellular glandular and eglandular. Leaves petiolate, opposite, ovate to elliptic-oblong, base attenuate, apex acute, margin entire, pubescent throughout; hairs multicellular. Cladodes sub-quadrangular–quadrangular, curved-straight, terminated with 2 or 4 hard spinous points, pubescent. Inflorescences axillary and terminal spike; bracts linear, apex acute, pubescent on outer surface, hairy-glabrous inside; bracteoles 2, linear, apex acute, pubescent on outer surface, hairy-glabrous inside. Calyx

5-partite; lobes sub-equal, pubescent throughout. Corolla outer side pubescent, glabrous inside; lobes sub-equal; tube curved. Stamens 2, included, adnate to the base of corolla; filaments flat, pubescent at base; anthers bithecous, ovoid, dorsifixed; connectives hairy. Ovary ovoid, apex pointed–blunt, glabrous–pubescent; style pubescent; stigma linear. Capsules linear-oblong, 3-ribbed, apex pointed, pubescent, 6–8-seeded. Seeds yellowish-brown to brown, ellipsoidal to oblong-ellipsoidal, compressed at base, hygroscopic hairy. Figure 1.

Phenology:—Flowering and Fruiting from January to August.

Habitat and ecology:—It occurs commonly in open places, on the sides of the roads and paths in shade.

Distribution:—INDIA. Goa, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu.

Figure 2.

Etymology:—From the greek *haplos* meaning simple or single, *anthos* referring to flower and *odes* meaning resembling. The generic epithet refers to the resemblance of the genus with *Haplanthus*.

Notes:—Panigrahi and Das (1981) selected *Haplanthodes verticillata* (Roxb.) R.B.Majumdar as the type species for the genus; however, this was not one of the species included by Anderson in his valid publication of *Haplanthus* in 1867, and hence is not eligible for type selection. In fact, any one of the four species, *Haplanthus hygrophiloides* (Anderson 1867: 503), *H. tentaculata*, *H. plumosa* and *H. verticillaris* mentioned by Anderson (1867) could have been chosen as the type species. Accordingly, here we have selected *Haplanthodes plumosa* (\equiv *Haplanthus plumosus*) as the type species.

Key to species of *Haplanthodes*

1. Cladodes stout, spiny *H. verticillata*
- Cladodes slender, not spiny 2
2. Feathery hairs present only on the lower half of the cladode; calyx 1/2 the length of corolla; cladodes up to 1.8 cm long *H. plumosa*
- Feathery hairs absent on the cladode; calyx 1/4 the length of corolla; cladodes up to 3 cm long 3
3. Ovary glabrous; bracts equal to length of calyx; cladodes 2–4 times longer than the length of corolla; seeds with micro-papillae .. *H. tentaculata*
- Ovary hairy; bracts shorter than the length of calyx; cladodes equal or shorter than the length of corolla; seeds without micro-papillae *H. neilgherryensis*

1. *Haplanthodes neilgherryensis* (Wight) Majumdar (1971: 76). \equiv *Haplanthus neilgherryensis* Wight (1850: 7, t. 1556), “*Neilgherrensis*”. \equiv *Haplanthodes tentaculata* var. *neilgherryensis* (Wight) Wood (2014: 386). **Type:**—India, Karnataka, “Neilgherries and Coorg jungles, s.d., Monro & Jerdon, s.n. (lectotype designated by Wood 2014: K barcode K000885689!).

Herbs, 50–90 cm tall. Stems quadrangular, pubescent; hairs dimorphic; unicellular eglandular 0.20–0.25 mm long; multicellular glandular 1.5–2.0 mm long. Leaves ovate to elliptic-oblong, 6.5–7.0 \times 3.5–4.0 cm, sparsely multicellular hairy on both sides; petioles 1–5 cm long. Cladodes pubescent, subquadrangular to quadrangular, up to 2 cm long, incurved. Inflorescences terminal, axillary spike, 4–10 cm long; bracts 0.8–2.5 \times 0.1–0.2 mm, pubescent on both side; bracteoles 1.0–2.5 \times 0.1–0.2 mm, similar to the bracts. Calyx 4.0–4.2 mm long; lobes 3.0–3.5 \times 0.4–0.5 mm. Corolla 8–15 mm long; lobes 5, sub-equal, 3.0–3.1 \times 2.0–2.1 mm; tube, 4–5 \times 1–2 mm; stamens 2, included, adnate to the base of corolla tube; filaments 1–2.2 mm long; anthers, 1.0–1.5 mm long. Ovary, 1.0–1.5 \times 0.1–0.6 mm, apex blunt, pubescent; style 5–8 mm long, hairy throughout. Capsules 5–6 \times 1–2 mm. Seeds pale–dark brown, oblong-ellipsoid, 0.8–1.25 \times 0.5–1.0 mm, hygroscopic hairy, compressed at base.

Distribution:—Endemic to India, occurring in Goa, Gujarat, Karnataka, Kerala, Maharashtra, Tamil Nadu.

Notes:—*Haplanthodes neilgherryensis* is closely related to *H. plumosa*, but differs in having cladodes hairy throughout (vs. hairy at lower half), internodes 1 cm long (vs. 2 cm), and seeds oblong-ellipsoid (vs. ellipsoid).

Wood (2014) followed Clarke (1885) and treated this species as a variety, i.e. *H. tentaculata* var. *neilgherryensis*. Wood (2014) indicated that he observed many specimens kept at Kew and several are intermediate between *H. tentaculata* var. *tentaculata* and *H. tentaculata* var. *neilgherryensis* and hence, he believed that a varietal status seems appropriate.

Turner (2021) merged this species with *H. tentaculata*. The species was described by Wight (1850) based on the characters of opposite axillary branches, shorter than the leaves, flowers racemose on the ends of branches and stem, calyx 5-parted, small and like the numerous bracts, setaceo-hispid, bracts linear, 2–3 toothed at the apex. Our observations reveal that in addition to the above characters, *H. neilgherryensis* differs from *H. tentaculata* in the length of the cladode (1 cm vs. 3 cm) and the presence of hairs on ovary (upper half hairy vs. ovary glabrous). Also, the seeds

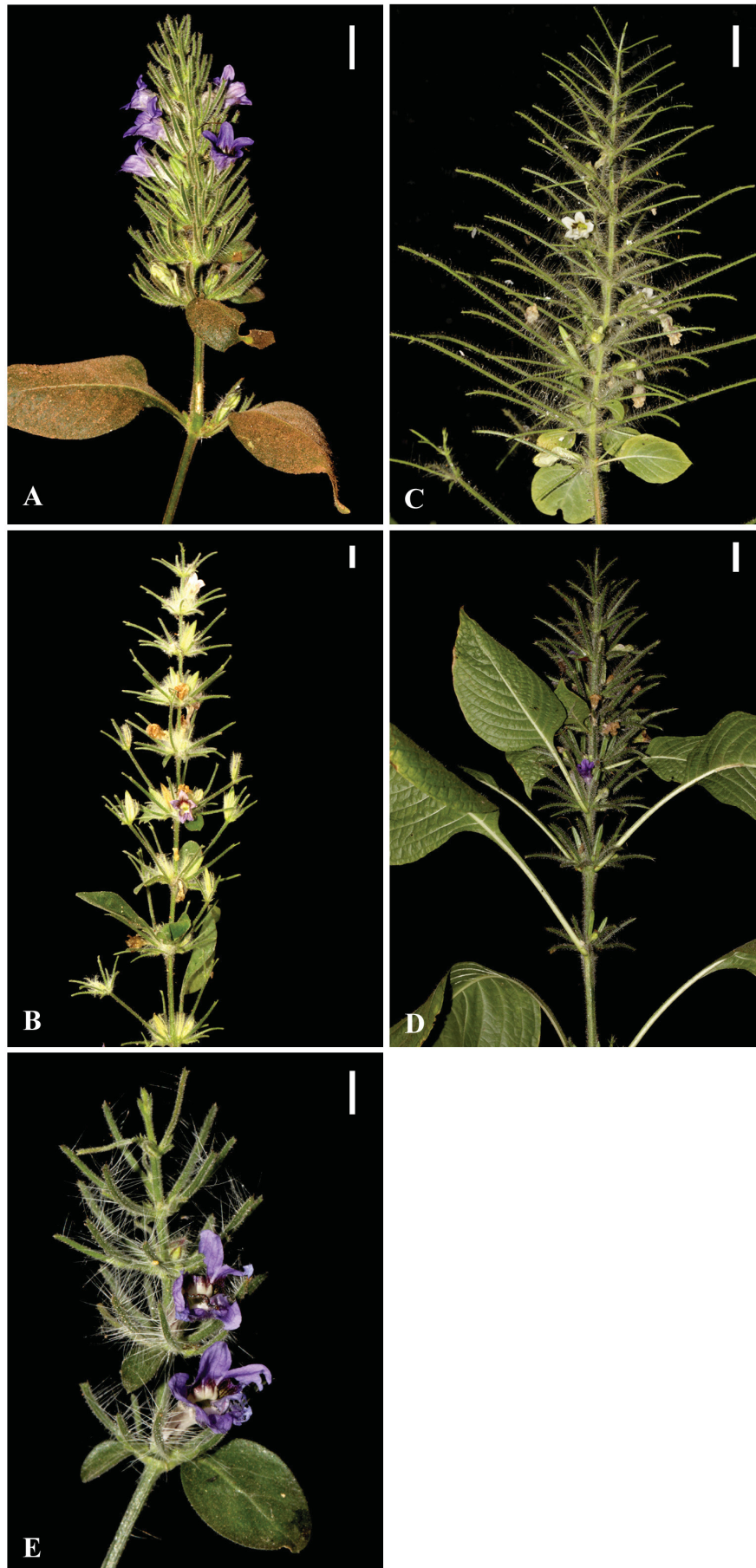


FIGURE 1. Inflorescences; A. *H. neilgherryensis* var. *neilgherryensis*, B. *H. plumosa*, C. *H. tentaculata*, D. *H. verticillata*, E. *H. neilgherryensis* var. *toranganensis*. Scale bars = 1 cm

in *H. neilgherryensis* are without micropapillae whereas micropapillate in *H. tentaculata*. Hence, here we treat *H. neilgherryensis* as a distinct species.

Wood (2014) lectotypified this name using the specimen housed at Kew herbarium (K000885689!). Turner (2021) overlooked that the name has been lectotypified by Wood (2014), whose selection must be followed according to the Article 9.19 of Shenzhen Code (Turland *et al.* 2018), and synonymized this species under *H. tentaculata* and retypified this name by designating another specimen from Kew herbarium (K000885687!) which must be superseded.

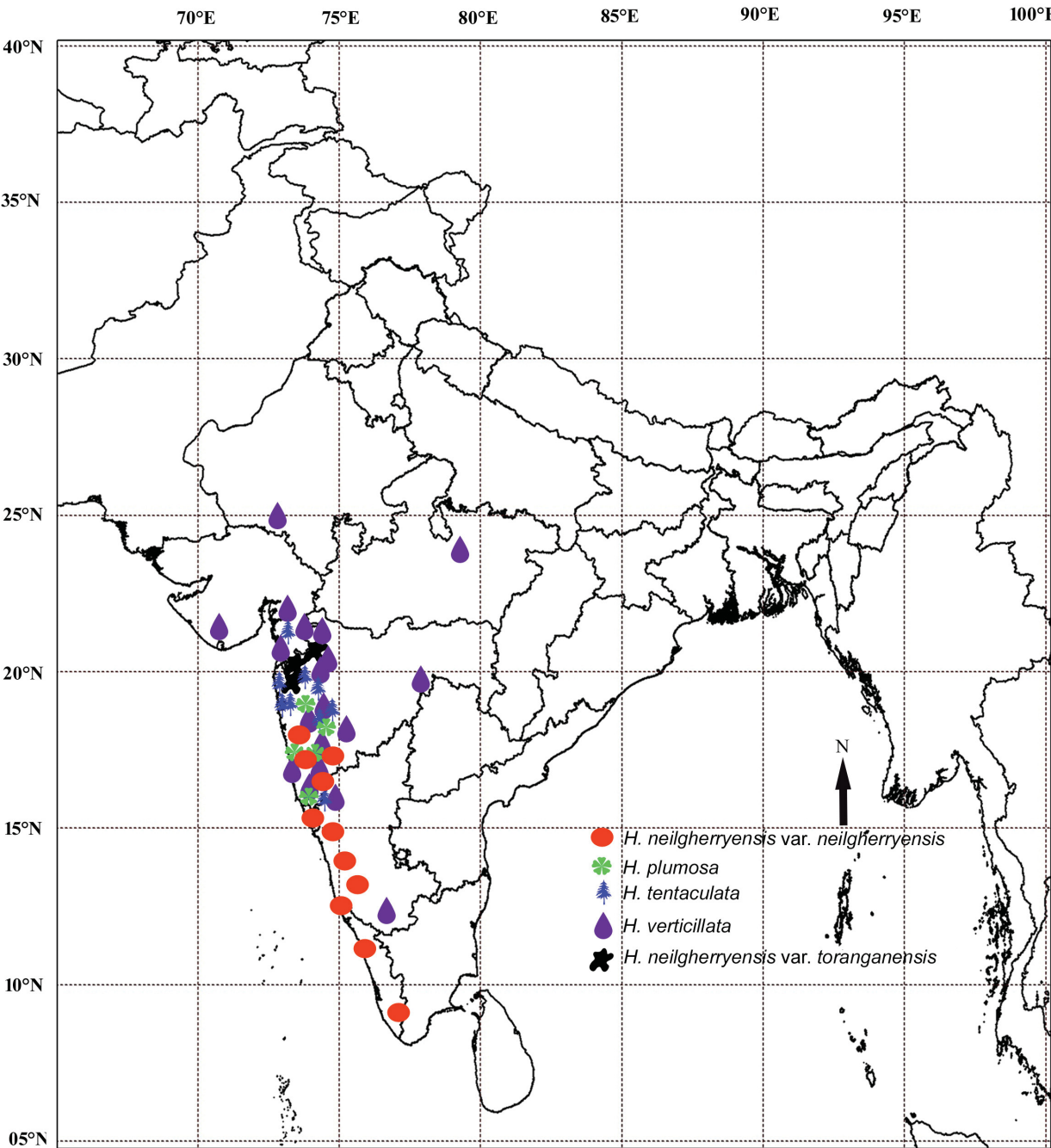


FIGURE 2. Geographical distribution of the genus *Haplanthodes*

Key to the varieties of *Haplanthodes neilgherryensis*

- 1a. Cladodes up to 1 cm long; ovary hairy only on the upper half var. *neilgherryensis*
- 1b. Cladodes up to 2 cm long; ovary hairy throughout var. *toranganensis*

1a. *Haplanthodes neilgherryensis* var. *neilgherryensis*

Herbs, 50–90 cm tall. Stems pubescent; hairs dimorphic; unicellular eglandular, 0.20–0.25 mm long; multicellular glandular 1.5–2.0 mm long. Cladodes sub-quadrangular up to 1 cm long. Bracts 0.8–1.0 mm long. Bracteoles 1.0–1.2 mm long. Corolla 5–6 mm long; filaments 1–2 mm long. Ovary 1.0–1.1 × 0.1–0.2 mm, upper half pubescent; style 5.0–5.5 mm long. Capsules 5–6 × 1–2 mm. Seeds pale-dark brown, 0.8–1.1 × 0.5–0.7 mm. Figure 3.

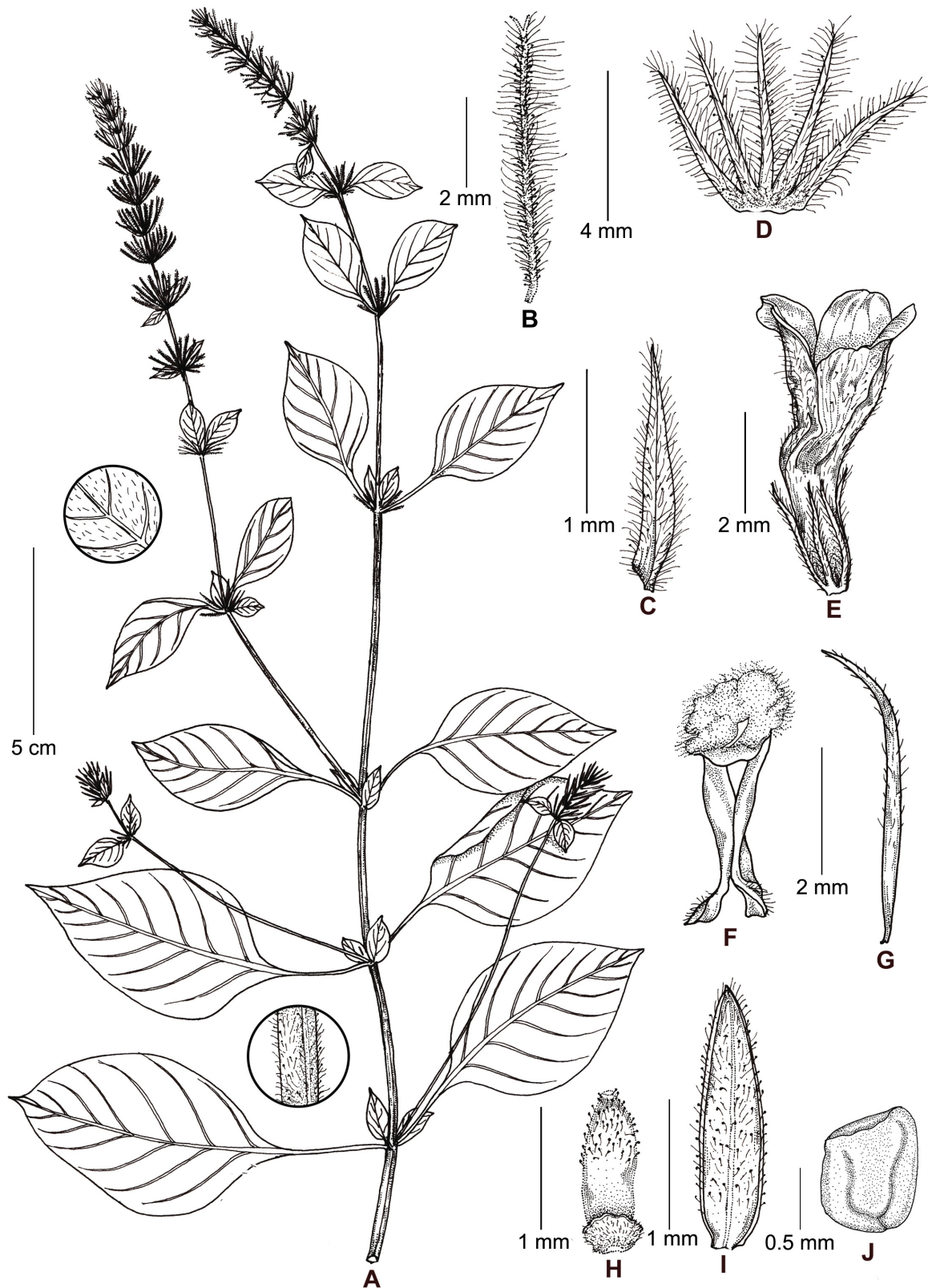


FIGURE 3. *H. neilgherryensis* var. *neilgherryensis*; A. Habit, B. Cladode, C. Bract, D. Calyx, E. Flower, F. Stamen, G. Style, H. Ovary, I. Fruit, J. Seed

Phenology:—Flowering and Fruiting from January to June.

Habitat and ecology:—It grows on lateritic slopes or bunds, in open areas, forest paths and as undergrowth on plateaus, at an altitude of 72–690 m asl.

Distribution:—Endemic to INDIA, occurring in Goa, Gujarat, Karnataka, Kerala, Maharashtra, and Tamil Nadu.

Additional specimens examined:—INDIA. GOA: Bansane village, near Tudal, 21 April 1963, *K.C. Kanodia 88191* (BSI); Wagal Hills forest, Budsane, 17 March 1964, *K.C. Kanodia 96340* (BSI); Kawaliya forest, near Nandove Volpoi area, 22 March 1964, *K.C. Kanodia 96421* (BSI, CAL). GUJARAT: Dang district, Dang forest, *s.d.*, *N.A. Irani 1699* (BLAT). KARNATAKA: Acharahar tower, 24 February 1970, *B.G. Kulkarni 120274* (BSI); Belgaum district, Jamgaon, 29 January 2017, *P.V. Deshmukh 518* (SUK); 18 February 2017, *P.V. Deshmukh 526* (SUK); Chikmagalur district, Ballalarayana Durga Fort, 26 February 1963, *R.S. Raghavan 86934* (BSI); Coorg district, 1871, *s.coll.*, *s.n.* (K); Bhimangundi Deciduous area, 26 February 1963, *A.S. Rao 85705* (BSI); Sara tabbi water falls, 26 February 1963, *A.S. Rao 86723* (BSI); Shimoga district, Hulikal Ghat, 32 miles from Agumbe, 15 February 1963, *R.S. Raghavan 86289* (BSI); Sagar, Jog Road, *s.d.*, *B.S. Ahuja 52016* (BSI); Kavaledurga fort, 24 May 1962, *R.S. Raghavan 80937* (BSI); 11 February 1963, *R.S. Raghavan 86048* (BSI); Agumbe, Balchalli, 24 May 1960, *R.S. Raghavan 62921* (BSI); South Kannada district, Subramanya, 28 January 1978, *R.S. Raghavan 152047* (BSI); Uttar Kannada district, Katgal, 2 May 1956, *Pury and Party 1946* (BSI); Maneri, 16 December 1962, *R.S. Raghavan 79645* (BSI); Yellapur, 15 February 1984, *W.A. Talbot 889* (CAL). KERALA: Amenkarwa, Tenmali Railway Station, 06 February 1961, *K.N. Subramaniam 63372* (BSI); Concan vicinity, Malabar, *s.d.*, Stocks, Law *s.n.* (P); Kasargod district, Perdala, 7 May 1982, *V.J. Nair 71046* (CAL); Malabar district, South Malabar, 21 January 1910, *C.E.C. Fischer 1643* (CAL). MAHARASHTRA: Concan, *s.d.*, Stocks, Law & Co., *s.n.* (L) (labelled as *Haplanthus tentaculatus*); Concan, *s.d.*, Stocks, Law & Co., *s.n.* (U); Jamunpada forest, 11 November 1970, *M.Y. Ansari 126859* (BSI); Buldhana district, hill slope, near Khamgaon, 5 miles northwest of Junnar, *K. Hemadri 98130* (BSI); on way to Khamgaon, fields near Kukdi River, *K. Hemadri 98210* (BSI); Chandrapur district, 23 January 1890, *J.F. Duthie 9645* (K); Kolhapur district, Amba, *s.d.*, *S.R. Yadav 5897* (SUK); *s.d.*, *M.M. Sardesai 935* (SUK); 26 January 2017, *M.M. Lekhak 517* (SUK); Pargad, 05 May 2016, *M.M. Lekhak 515* (SUK); Anuskura Ghat, 02 January 2017, *P.V. Deshmukh 533* (SUK); On the way Karanjpe to Kante, 01 February 2017, *M.M. Lekhak 519* (SUK); Radhanagari, 08 February 2017, *M.M. Lekhak 523* (SUK); Shirshingi, 10 April 1978, *M.P. Nayar 103067* (BSI); January 1994, *M.P. Bachulkar 5695* (SUK); Tillari, 26 February 2017, *M.M. Lekhak 527* (SUK); Mumbai district, Chikuwadi, 18 November 1954, *G.L. Shaha 1074* (BLAT); Malad, 14 December 1957, *G.L. Shaha 9633, 1131* (BLAT); National Park, Borivali, 29 January 1951, *G.J. Randeria 737, 168* (BLAT); Nashik district, Velunja (Ambai), 04 February 1983, *P.L. Narsimahan 165343* (BSI); Pune district, shivneri hills, 26 March 1964, *K. Hemadri 98017* (BSI); On the way to Dongerpad–Umberkoi, 07 November 1970, *M.Y. Ansari 121975* (BSI); on way to Khamgaon, fields near Kukdi River, 11 May 1964, *K. Hemadri. 98210* (BSI); on the way to Khandala bridge, 7 March 1962, *S. R. Rolla 77680* (BSI); Pune district, Ambavane, Sultan nala, 28 March 1964, *K. Hemadri 97625* (BSI); *B.V. Reddi 97625* (CAL); Ghaber-Ula-Nas, 25 January 1961, *K.P. Janardhanan 66488* (BSI); On the way to Khandala bridge, 7 March 1962, *S.R. Rolla 77680* (BSI); Pune, 9 November 1903, *G.A. Gammy 16455* (BSI); Kuna hills, Lonavala, 06 May 1956, *S.K. Jain 954* (BSI); Nagar Haveli, Velugaon, 15 November 1970, *M.Y. Ansari 127105* (BSI); Research nursery, 14 April 1978, *M.P. Nayar 153109* (BSI); Raigad district, Alibag parhar, Kolaba, 23 May 1958, *S.K. Jain 35768* (BSI); Bansane village, 21 April 1963, *K.C. Kanodia 88191* (CAL, BSI); Kolaba fort, 23 May 1958, *S.K. Jain 35768* (CAL); Mangaon 9 km from Akeri, 14 February 1966, *M.Y. Ansari 107772* (BSI); Ratnagiri district, Bhedshi, Hewale, 28 April 1971, *B.G. Kulkarni 129390* (BSI); Gavata, 5 km from Bhedshi, 18 February 1966, *M.Y. Ansari 108351* (BSI); Ghotane, 40 km from Kudal, 16 February 1966, *M.Y. Ansari 107682* (BSI); Chafeli, Kerude jungle, 13 February 1970, *B.G. Kulkarni 120081* (BSI); Kanhale, 8 km from Bhedshi, 20 February 1966, *M.Y. Ansari 108450* (BSI); Konal R.F., 30 April 1971, *B.G. Kulkarni 129421* (BSI); Sindhoni forest, 14 November 1970, *M.Y. Ansari 127068* (BSI); Vihigaon R.F. Vihigaon range 05 Jun 1968, *K.V. Billore 116173* (BSI); On the way Karanjpe to Kante, 02 January 2017, *M.M. Lekhak 519* (SUK); Rajapur, 09 March 2017, *P.V. Deshmukh 532* (SUK); Satara district, Kas Plateau, January 1994, *M.P. Bachulkar 5654* (SUK); Koyana, Punali, 10 February 1979, *R.K. Kochhar 158302* (BSI); Koyana, Forest nursery, 26 December 1978, *R.K. Kochhar 158012* (BSI); Ratnagiri hills, 20 March 1963, *S.R. Rolla 87284 A* (BSI); 10 miles from Mahabaleshwar on Pratapgad road, 9 May 1961, *S.R. Rolla 71729* (BSI); Sindhudurg district, Amboli, 26 February 2017, *M.M. Lekhak 529* (SUK); 13 April 2017, *P.V. Deshmukh 534* (SUK); Amboli Ghat, Kunkeshwar, 18 May 1965, *R.P. Pataskar 105211* (BSI); Bambarde, 26 February 2017, *M.M. Lekhak 528* (SUK); Kankavali, 05 February 2017, *M.M. Lekhak 521* (SUK); Nashik district, Igatpuri, 26 December 1958, *Y.A. Merchant 800* (BLAT); Thane district, Ghodbandar, November 1924, *Sedgwick & Blatter 110* (BLAT); 23 January 1954, *H. Santapau 17936* (BLAT); Thane district, Junagadh basin, *s.d.*, *G.M. Ryan 12 A* (BSI); Kasara, 14 April 1957, *S.K. Jain 14735* (CAL); Mumbra, 05 January 1954, *K.V. Shenoy 1905*, 19 January 1954, *K.V.*

Shenoy 2026, 2027, 9 February 1954, *K.V. Shenoy 2119* (BLAT); Parol, 11 January 1962, *N.Y. Das 6650, 6649* (BLAT); Vihigaon range forest, 5 June 1968, *K.V. Billore 116173* (CAL). TAMILNADU: Coimbatore district, Yanaikundhi Shola Forest, 29 January 1962, *J. Joseph 13809* (MH).

Notes:—It was reported by Clarke (1885), Cooke (1908) and Panigrahi & Das (1981) that capsules are 6–16-seeded, we found its capsules have 8 seeds only.

1b. *Haplanthodes neilgherryensis* var. *toranganensis* P.V.Deshmukh & Lekhak, var. nov. **Type:**—India. Maharashtra: Nashik district, Torangan Ghat, 30 January 2018, *P.V. Deshmukh & M.M. Lekhak MML 545* (holotype CAL!, isotypes BSI!, SUK!). Figure 4.

Diagnosis:—The new variety differs from var. *neilgherryensis* by its cladodes up to 2 cm long (vs. up to 1 cm long), internodes lax (vs. compact), corolla 10–15 mm long (vs. 5–6 mm long), ovary hairy throughout (vs. ovary hairy only on the upper half), seeds densely hygroscopic hairy (vs. sparsely hygroscopic hairy).

Herbs, 70–90 cm tall. Stems pubescent; hairs dimorphic; unicellular eglandular, 0.2–1.0 mm long; multicellular glandular 0.2–0.3 mm long. Cladodes quadrangular, up to 2 cm long. Bracts 2.2–2.5 mm long; bracteoles 2.2–2.5 mm long. Corolla 10–15 mm long. filaments 2.0–2.2 mm long. Ovary 1.0–1.5 × 0.5–0.6 mm, hairy throughout; style 5–8 mm long. Capsules 5–7 × 1–2 mm. Seeds dark brown, 1.0–1.25 × 0.7–1.0 mm. Figure 5.

Phenology:—Flowering and fruiting from January to June

Habitat and ecology:—Found along the roadsides in Deciduous forest under shady conditions.

Distribution:—Endemic to India, occurring in Maharashtra; Endemic.

Etymology:—The varietal epithet “*toranganensis*” refers to its type locality, Torangan Ghat, Nashik district, Maharashtra, India.

Additional specimens examined:—INDIA. MAHARASHTRA: Nashik district, Pahine, 2 December 2017, *P.V. Deshmukh & S.S. Patil 538* (SUK); on the way to Tryambakeshwar to Pahine, 2 December 2017, *P.V. Deshmukh & S.S. Patil 541* (SUK); Torangan Ghat, 20 January 2018, *P.V. Deshmukh & M.M. Lekhak 544* (SUK); Thane district, Kasara Ghat, 2 December 2017, *P.V. Deshmukh & S.S. Patil 539* (SUK).

2. *Haplanthodes plumosa* (T.Anderson) Panigrahi & Das (1981: 200). ≡ *Haplanthus plumosus* Anderson (1867: 504). ≡ *H. tentaculata* var. *plumosa* (T.Anderson) Majumdar (1971: 76). **Type:**—INDIA, Maharashtra state, Concan region, *s.d.*, *Stocks 4* (lectotype **designated here!**: K barcode K000885684!)

Herbs, 40–50 cm tall. Stems quadrangular, pubescent, hairs dimorphic, unicellular eglandular, 0.1–0.2 mm long, multicellular glandular, 0.20–0.25 mm long. Leaves ovate to elliptic-oblong, 6.0–7.0 × 3.0–4.5 cm, sparsely multicellular hairy on both sides; petioles 0.5–5.0 cm long. Cladodes quadrangular, up to 1.8 cm long, recurved. Inflorescences 5–8 cm long; bracts 0.9–1.0 × 0.1–0.2 mm, pubescent on outer surface, glabrous inside; bracteoles 2, linear, 1.0–1.2 × 0.1–0.2 mm, similar to bracts. Calyx 6–7 mm long; lobes 5.0–6.0 × 0.1–0.2 mm. Corolla 5–6 mm long; lobes 2.0–2.2 × 2.0–2.1 mm; tube 4–5 × 1–2 mm. Stamens 2; filaments 1.5–2.0 mm long; anthers 1.0–1.5 mm long. Ovary 1.0–1.5 × 0.2–0.5 mm, apex pointed, upper half portion pubescent; style 5–6 mm long, hairy throughout. Capsules 7.0–8.0 × 2.0–2.5 mm. Seeds dark brown, ellipsoid, 0.5–1.0 × 0.7–0.9 mm, hygroscopic hairy, compressed at base. Figure 6.

Phenology:—Flowering and Fruiting from January to June.

Habitat and ecology:—It grows mostly along the edges of the forest, roadsides and as an undershade in deciduous forests.

Distribution:—Endemic to India, occurring in Maharashtra.

Notes:—It resembles *Haplanthodes neilgherryensis* var. *neilgherryensis* but differs in the cladodes densely plumose hairy on lower half part (vs. hairy throughout), internodes 2 cm long (vs. 1 cm long), calyx densely plumose hairy (vs. not densely plumose hairy), and seeds ellipsoid (vs. not ellipsoid).

Anderson (1867) described the species based on the collection of Stocks and Law. He, however, did not provide any information on the specimens or types. In search of the original material we could trace five duplicates collected from Concan, India with collection number ‘4’, two at CAL (CAL0000019471 & CAL0000019472), two at P (P03590538 & P03590542) and one at K (K000885684). The duplicate at K annotated by Anderson, is chosen as the lectotype following Art. 9.11 of the Shenzhen Code (Turland *et al.* 2018).

Wood (2014) overlooked the revision by Panigrahi & Das (1981) and erroneously mentioned that the combination *H. tentaculata* var. *plumosa* was made by Panigrahi & Das. In fact, the combination was made by Majumdar (1971).

Additional specimens examined:—INDIA. KARNATAKA: Belgaum, December, *D. Ritchie 577/2* (K).

MAHARASHTRA: Concan, *s.d.*, *Stocks, Law 202660* (L); Concan, *s.d.*, *Stocks 28* (MH); Mumbai district, April 1878, *N.A. Dalzell s.n.* (K); Nashik district, Igatpuri, 26 December 1958, *Y.A. Merchant 801* (BLAT); Pune district, Ambavane fort, 26 October 1964, *B.V. Reddi 99483*; 28 December 1964, *B.V. Reddi 101084* (BSI); Ambavane, Kate

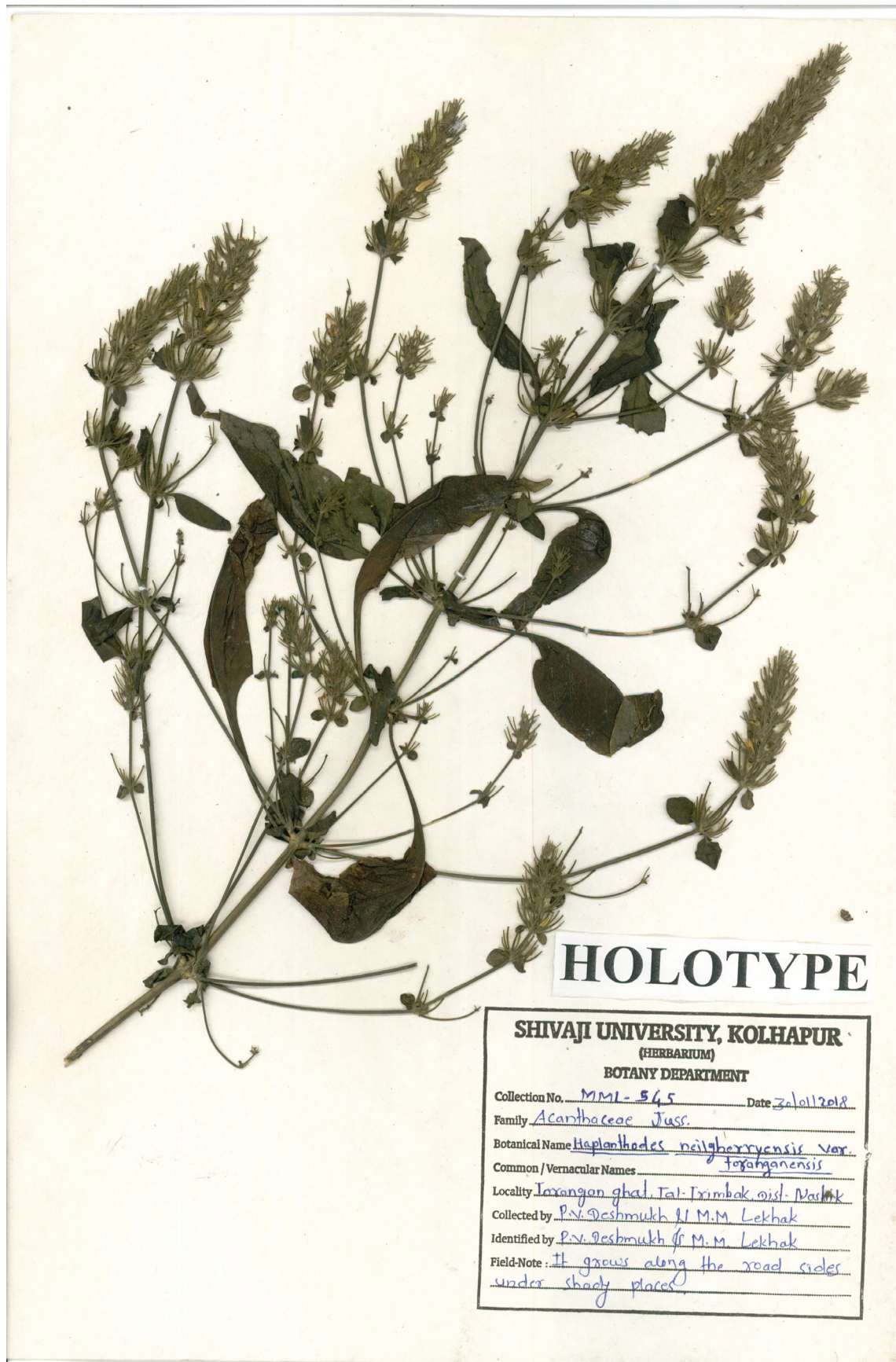


FIGURE 4. Holotype of *H. neilgherryensis* var. *toranganensis* (MML 545 deposited in CAL)

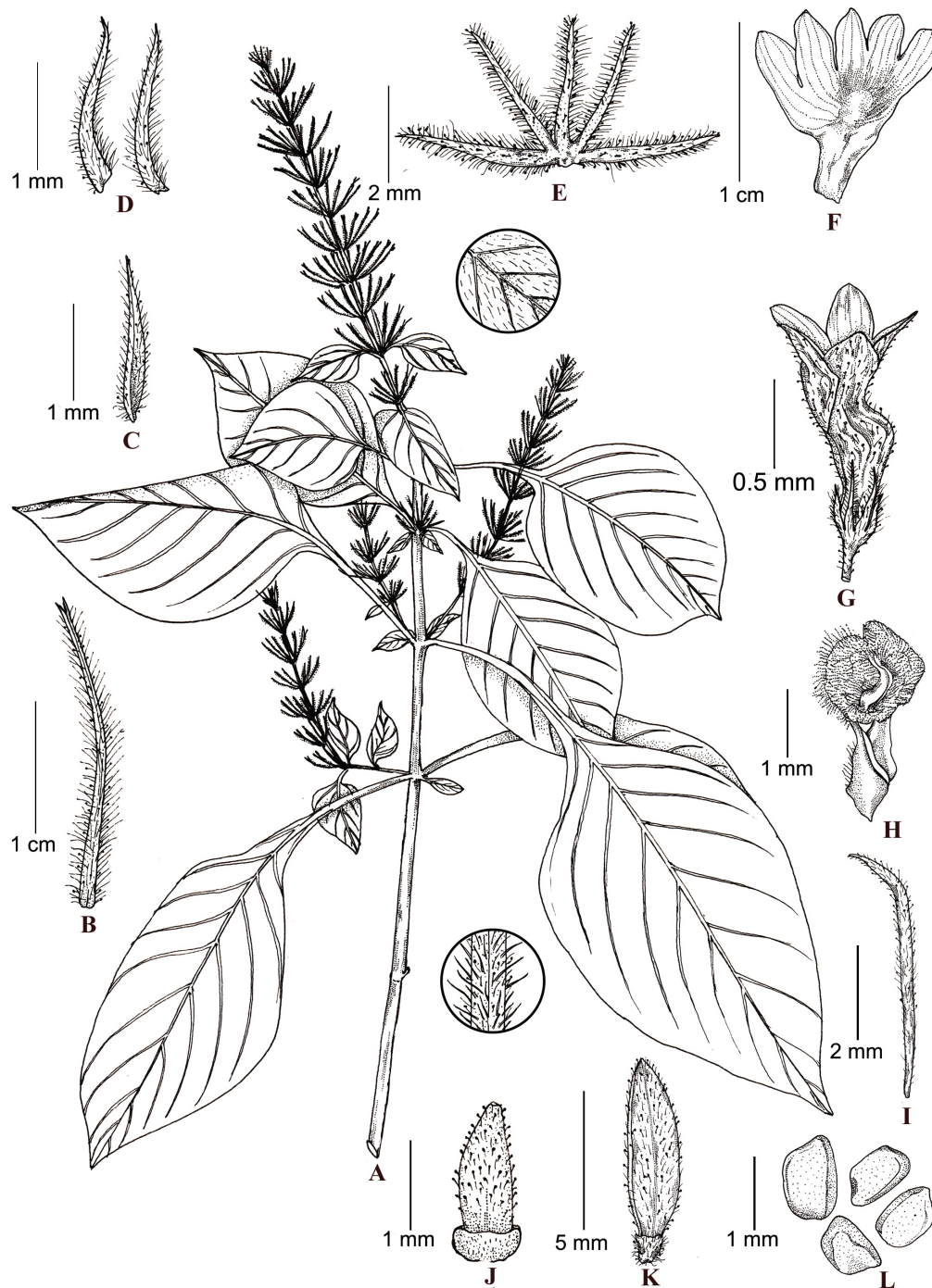


FIGURE 5. *H. neilgherryensis* var. *toranganensis*; A. Habit, B. Cladode, C. Bract, D. Bracteoles, E. Calyx, F. Corolla, G. Flower, H. Stamen, I. Style, J. Ovary, K. Fruit, L. Seeds

Pani Forest, on way to Kolaba, 28 December 1964, *B.V. Reddi* 95949 (BSI); Way to Deccan, *s.coll.*, *s.n.* (P); Khandala, 22 May 1957, *J.A. Vasavda* 17130 (CAL); *H.S. Santapau* 9708; 30 December 1942, *H.S. Santapau* 1460; 23 December 1943, *H.S. Santapau* 3409 (BLAT); 5 March 1987, *H.S. Santapau* 3687 (P); Echo point, 12 December 1952, *H.S. Santapau* 15364 (BLAT); Elephant point, 20 December 1949, *H.S. Santapau* 10594, 10593 (BLAT); Raigad district, Matheran, 13 December 1958, *N.A. Irani* 2668; 11 November 1960, *N.A. Irani* 5649 (BLAT); Ratnagiri district, Sangameshwar, 14 April 2017, *P.V. Deshmukh* 536 (SUK); Satara district, Battery hills, 7 March 1962, *S.R. Rolla* 69754 (BSI); Sindhudurg district, Amboli, 16 February 2017, *P.V. Deshmukh* 524 (SUK); Amboli, 12 February 2018, *P.V. Deshmukh* 546 (SUK).

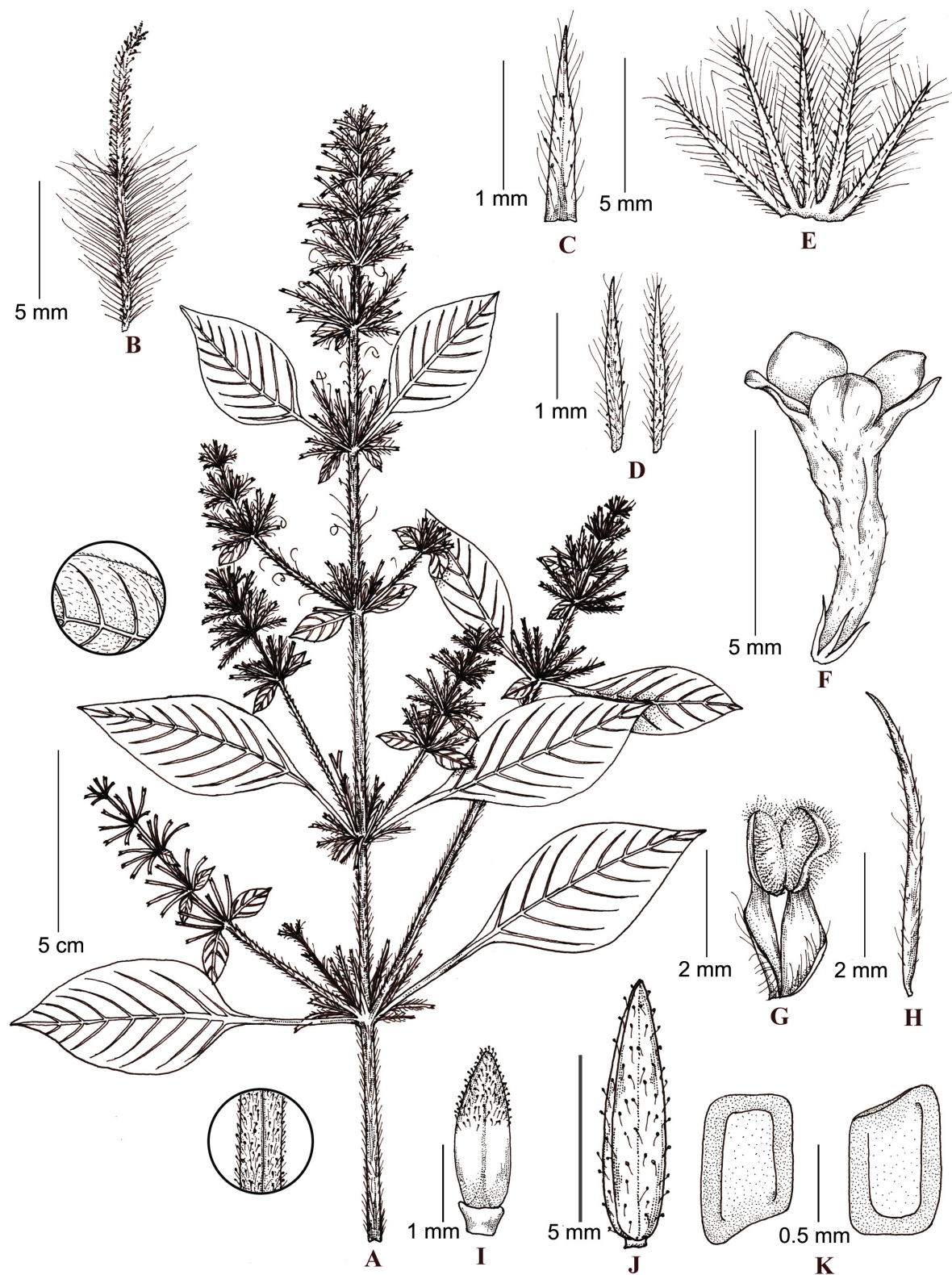


FIGURE 6. *H. plumosa*; A. Habit, B. Cladode, C. Bract, D. Bracteoles, E. Calyx, F. Flower, G. Stamen, H. Style, I. Ovary, J. Fruit, K. Seeds

3. *Haplanthodes tentaculata* (L.) Majumdar (1971: 76). ≡ *Ruellia tentaculata* Linnaeus (1756: 22). Type:—India, Gujarat, Surat, LINN. Herb. No. 804.9 (lectotype designated by Panigrahi & Das 1981: LINN!)

Ruellia aciculata Roth (1821: 301) Type:—unknown.

Herbs, 70–90 cm tall. Stems quadrangular, pubescent; hairs dimorphic; multicellular eglandular, 4–5 mm long; multicellular glandular, 2–3 mm long. Leaves ovate to elliptic-oblong, 0.7–5.0 × 1.5–2.0 cm, sparsely multicellular hairy on both sides; petioles 0.2–2.0 cm long. Cladodes quadrangular, up to 3 cm long, straight. Inflorescences 5–10 cm long; bracts 2.0–2.2 mm long, pubescent on outer surface, glabrous inside; bracteoles 1.0–1.5 mm long, similar to bracts. Calyx 2–3 mm long; lobes 2.0–2.1 × 0.1–0.2 mm. Corolla 5–6 mm long; lobes 2.0–2.5 × 1.5–2.0 mm; tube 5–6 × 1–2 mm. Stamens 2; filaments 1.5–2.0 mm long; anthers 1.0–1.5 mm long. Ovary 1.0–1.2 × 0.1–0.2 mm, apex pointed, glabrous; style 5–6 mm long, hairy throughout. Capsules 7–8 × 1–2 mm. Seeds brown, ellipsoid, 1.5–2.0 × 0.4–0.6 mm, slightly compressed at base. Figure 7.

Phenology:—Flowering and Fruiting from January to June.

Habitat and ecology:—It grows in ghat areas along the roadsides.

Distribution:—Endemic to India, occurring in Gujarat, Kerala, Maharashtra.

Affinities:—*Haplanthodes tentaculata* is similar to *H. verticillata*, but differs in having soft and filiform cladodes (vs. stout cladodes), ending in two soft teeth (vs. ending in two hard spinous teeth).

Notes:—*H. tentaculata* was originally described as *Ruellia tentaculata*. In the protologue, Linnaeus (1756: 22) referred drawing ‘7’ in Plukenet’s *Phytographia*. Jarvis (2007) indicates that the original material include two specimens (Herb. Linn. No. 262.5 at S and 804.9 at LINN) and icons in *Phytographia* and *Algamestum Botanicum*. Jarvis (2007) might have overlooked that the name has been lectotypified by Panigrahi and Das (1981) who designated Herb. Linn. No. 804.9 (LINN) as the lectotype using the term “type”, and considers *R. tentaculata* to be untypified.

Turner (2021) designated a neotype for the name *R. aciculata* which is a heterotypic synonym of *H. tentaculata*. He selected the specimen from Kew Herbarium (K000885689!) as a neotype which already serves as the lectotype for the name *H. tentaculata* var. *neilgherryensis* (Wood 2014) and hence, Turner’s choice must be superseded.

Additional specimens examined:—INDIA. GUJARAT: Surat, *s.d. s.coll.* 804.9 (CAL); Vadodara district, 01 January 1955, *G.L. Shaha* 1435 (BLAT); Dang district, Dang forest, 09 March 1954, *H.S. Santapau* 18264 (BLAT); Surat district, Bank of Tapti river, November 1884, *T. Cooke* 162 (CAL). KERALA: Anamala hills, *s.d.*, *Beddome* 66 (CAL). MAHARASHTRA: Ahmednagar district, Naneghat-Tokavade range, 13 March 1967, *K.V. Billore* 110918 (BSI); Kolhapur district, Tillari Ghat, 26 February 2017, *M.M. Lekhak* 531 (SUK); Mumbai district, *s.d. N.A. Dalzell* (K000885683) (K); Borivali, National Park, 08 November 1951, *G.J. Randeria* 143; 23 April 1952, *G.J. Randeria* 263; 09 February 1952, *G.J. Randeria* 202 (BLAT); Malad, 20 January 1956, *G.L. Shaha* 6774, 6775 (BLAT); Marve road, 05 January 1957, *G.L. Shaha* 8449 (BLAT); Vihar lake, 27 November 1958, *Y.A. Merchant* 758 (BLAT); Palghar district, Chahadkhind forest, Palghar range, 15 January 1968, *K.V. Billore* 113589 (BSI); Kedarnath hill plateau, 17 November 1968, *K.V. Billore* 115549 (BSI); Khunvada R. F. Bordi Range, 11 January 1968, *K.V. Billore* 113443 (BSI, CAL); Bassein Fort, Gokhivare range, 21 January 1968, *K.V. Billore* 113727 (BSI, CAL); Vasai fort, 05 February 1949, *H.S. Santapau* 9895 (BLAT); Pune district, Ambavane, Kate Pani forest, 26 October 1964, *B.V. Reddi* 99483 (CAL); on way to fort, 28 October 1964, *B.V. Reddi* 101084 (CAL); Katraj, 27 March 1956, *G.S. Puri* 86 (BSI); Khandala, *s.d.*, *s.coll.*, *s.n.* (BSI); Khandala, December 1902, *G.A. Gammie s.n.* (BSI); 12 December 1952, *H.S. Santapau* 15395 (BLAT); Sidhagad-Murbad range, 12 April 1968, *K.V. Billore* 113886 (BSI); Raigad district, Uran, 15 January 1963, *P. Divekar* 5774 (BLAT); Matheran, 3 November 1907, *H.P. Paranjape s.n.* (BSI); Satara district, Mahabaleshwar, 27 January 1917, *M. Ezekiel s.d.* (BLAT); Thane district, Bordi range, 10 January 1968, *K.V. Billore* 113414 (BSI, CAL); Gambhirgad, Udhawa range, 25 October 1967, *K.V. Billore* 113240 (BSI, CAL); Murbad range, Sidhagad fort, 12 April 1968, *K.V. Billore* 113886 (CAL); Salsette range forest, 20 February 1900, *G.M. Ryan* 35 (MH).

4. *Haplanthodes verticillata* (Roxb.) Majumdar (1971: 76). ≡ *Justicia verticillata* Roxb. (1820: 135). Type:—INDIA, Madhya Pradesh, Ujjain, *Hunter s.n.* (not seen).

= *Haplanthus verticillaris* Nees (1847: 513) (lectotype **designed here**: Purimdar (now Purandar, Pune district, Maharashtra), *Jacquemont*. 192 (GZU000245996!)).

Herbs, 50–90 cm tall. Stems quadrangular, pubescent; hairs dimorphic; multicellular eglandular 2–3 mm long; multicellular glandular, 1–2 mm long. Leaves ovate to elliptic-oblong, 10–11 × 3–5 cm, sparsely multicellular hairy on

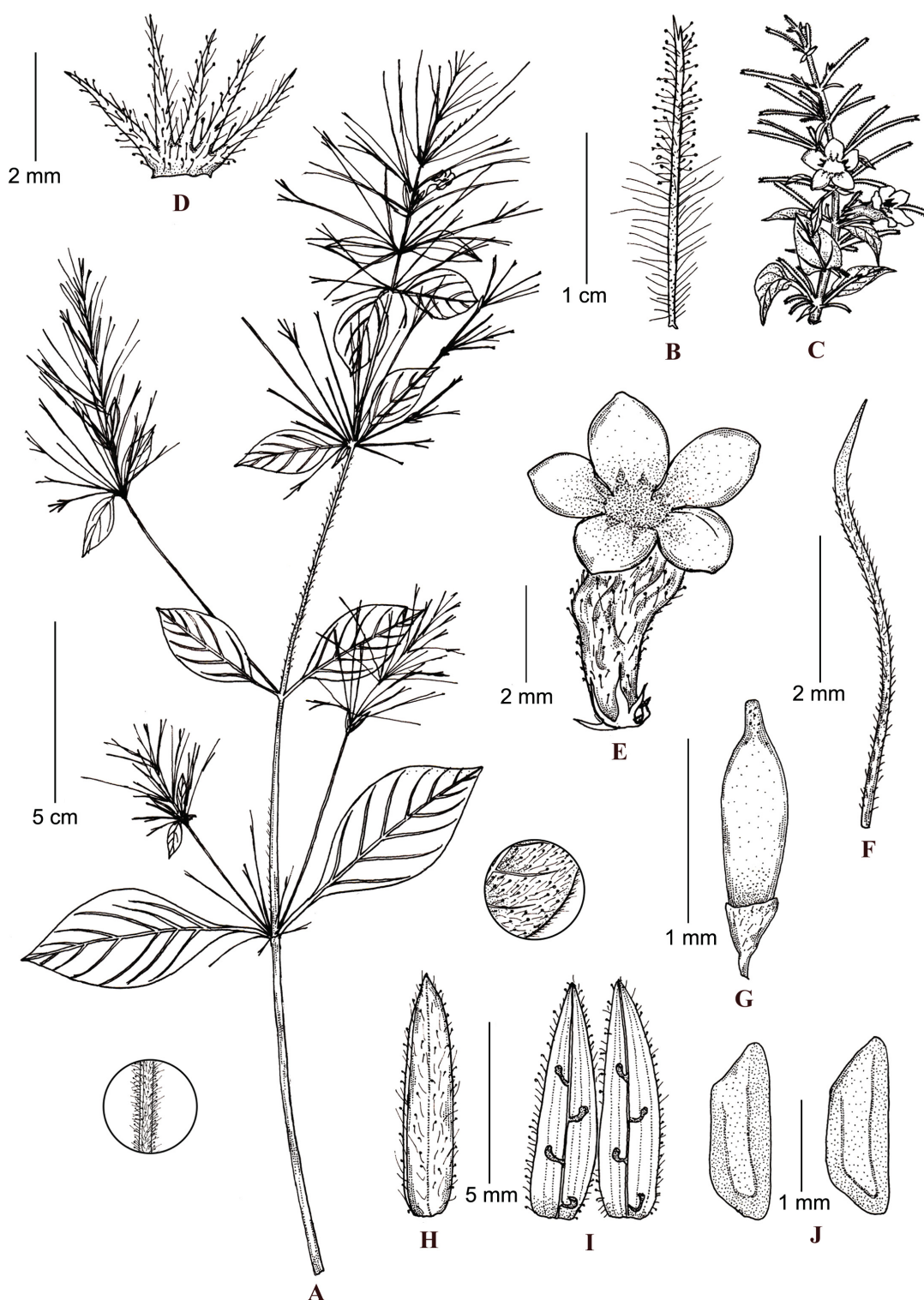


FIGURE 7. *H. tentaculata*; A. Habit, B. Cladode, C. Inflorescence, D. Calyx, E. Flower, F. Style, G. Ovary, H. Fruit, I. Opened capsule. J. Seeds.

both sides; petioles 3–5 cm long. Cladodes in whorls (15–20) quadrangular, up to 2.5 cm long, terminated with 2 or 4 hard spinous points. Inflorescences an axillary spike, 8–10 cm long; bracts $3\text{--}4 \times 1\text{--}2$ mm, pubescent on outer surface, glabrous inside; bracteoles $4\text{--}5 \times 1\text{--}2$ mm similar to bracts. Calyx 4–5 mm long; lobes $3.0\text{--}4.0 \times 0.2\text{--}0.3$ mm. Corolla 5–6 mm long; lobes $3.0\text{--}3.2 \times 2.0\text{--}2.2$ mm; tube $6\text{--}7 \times 1\text{--}2$ mm. Stamens 2; filaments flat, 2–3 mm long; anthers, 1.0–1.2 mm long. Ovary $1.0\text{--}1.2 \times 0.5\text{--}0.6$ mm, apex pointed, pubescent; style 5–6 mm long, pubescent throughout. Capsules $8\text{--}13 \times 2\text{--}3$ mm. Seeds brown, ellipsoid, $2.0\text{--}2.5 \times 1.0\text{--}1.5$ mm, hygroscopic hairy, slightly compressed at base. Figure 8.

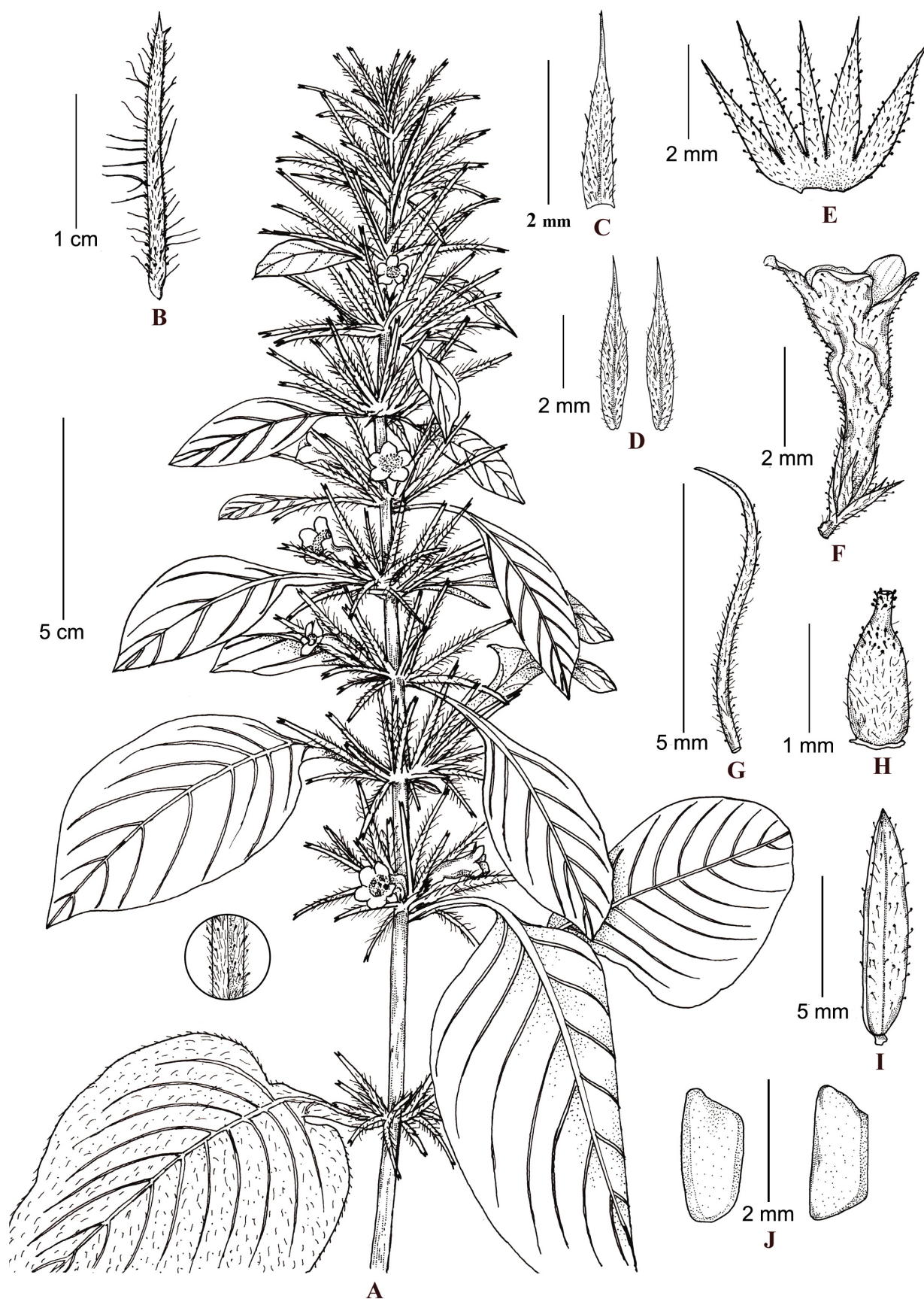


FIGURE 8. *H. verticillata*: A. Habit, B. Cladode, C. Bract, D. Bracteoles, E. Calyx, F. Flower, G. Style, H. Ovary, I. Fruit, J. Seeds.

Phenology:—Flowering and Fruiting from January to August.

Habitat and ecology:—It grows along the roadsides, forest paths in shade as well as in open space.

Distribution:—Endemic to India, occurring in Goa, Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan.

Affinities:—*H. verticillata* resembles *H. tentaculata*, but differs from it in having stout cladodes arranged in a whorl (vs. not arranged in a whorl).

Notes:—The type specimen of *Haplanthodes verticillata* (Hunter s.n.) could not be located. Hunter (William Hunter) was a Secretary of the Aisatick Society, Calcutta and associated with Roxburgh (Forman 1989). We could not locate any specimen of *H. verticillata* that can be linked either to Hunter or Roxburgh. As we could not confirm that the type is lost we refrain from designating the neotype. However, once the loss of the type is confirmed this binomial needs to be neotypified.

Nees (1847) described *Haplanthus verticillaris*, a heterotypic synonym of *Haplanthodes verticillata* (Roxb.) R. B. Majumdar. Nees (1847) cited following sheets in the protologue: Perrottet! in herb. DC., Jacquemont! in h. mus. paris. et Nees no. 192 (from mountain regions of Purandar), Perrottet! in h. mus. paris. et Nees, n. 131) (from Neelgherries) and Griffith! in h. hooker (Assam). He did not specify the type specimen and hence all these specimens constitute syntypes. Our search for these specimens at K, Herbarium of Geneva (DC), National Museum of Natural History, Paris (P) could not locate any original material. Rather, we could find these specimens at Karl-Franzens Universitat Graz herbarium (GZU), of which GZU000245996! is selected here as the lectotype. One of the specimens cited in the protologue, Griffith! in h. hooker (GZU000260947) was from Assam. There is no corresponding specimen to the barcode GZU000260947. Also, we could not find any specimen of the genus *Haplanthodes* from the north east India in any of the Indian herbaria. Hence, we have not included Assam under the distribution range of the genus as well as of the species, *H. verticillata*.

Additional specimens examined:—INDIA. GOA: Mandovi, bepa forest, s.d., S.R. Rolla 89136 (CAL). GUJARAT: Bharuch district, Kabirvad, 10 December 1901, H.M. Chiltern s.n. (BSI); Dang district, Ahwa, 09 June 1958, S.K. Jain 38412 (BSI); Chinchli, 23 November 1959, B.M. Wadhwa s.n. (BSI); Girnar forest, Junagadh, 22 December 1959, M.Y. Ansari 59862 (BSI); Valsad district, Ancha forest, 14 June 1958, P.S. Taur 39077 (BSI). KARNATAKA: Belgaum district, s.d., N.V. Malpure 2349 (SUK); Mandya district, 12 February 1961, J. Joseph 12262 (MH). MADHYA PRADESH: Damoh district, Rangir, near Rehli, 06 March 1960, K. Subramanyam 10188 (MH); on the way Mile to Manipur on Bombay-Agra road from the southern side, 22 April 1962, A.R.K. Shastry 87527 (BSI); Indore district, Barkheda to Chapria village (near Manipur), 22 December 1961, A.S. Rao 79305 (BSI); Kasturbagram krishi kshetra, 18 April 1987, K.K. Khanna and R. Sarad 38791 (CAL). MAHARASHTRA: Ahmednagar District, Harishchandragad Fort, Kedarnath Hill slope, 20 November 1968, K.V. Billore 115825 (BSI); Buldhana district, Ambhabarula valley, 18 December 1982, P.G. Gaikawad 164711 (BSI); Khunvada R.F. Bordi range, 11 January 1968, K.V. Billore 113457 (BSI); Kolhapur district, Panhala, 20 November 1996, M.M. Sardesai 666 (SUK); 09 March 2017, P.V. Deshmukh 553 (SUK); Pargad, 13 May 2017, M.M. Lekhak 516 (SUK); Patgaon, 26 February 2017, M.M. Lekhak 530 (SUK); Radhanagari, 08 February 2017, P.V. Deshmukh 522 (SUK); Hasane, 20 December 2018, P.V. Deshmukh 554 (SUK); Nandurbar district, 06 January 1957, S.K. Jain 11091 (BSI); Mumbai (Bombay), 1827, s.coll. s.n. (L); Nashik district, Peint beat, 06 February 1983, P.C. Narasimahan 165373 (BSI); On way to Jungli Jaigad, Koyana Lake, 23 November 1978, R.K. Kochhar 157802 (BSI); on border of Yavatmal and Nanded district, native forest, 22 December 1976, S. Karthikeyan 148531 (BSI); Toranmal hills, Yashvant lake, 10 March 1965, R.D. Pataskar 105105 (BSI, CAL); Palghar district, Vihigaon range, Utawada hill, near Mokhada, 21 October 1967, K.V. Billore 116184 (BSI, CAL); near Mokhada Washala range, Dhuri Hill, 19 October 1967, Kurillore 112906 (BSI); Pune district, Ambavane Forest, 24 December 1963, B.V. Reddi 93420 (BSI, CAL); Ambavane road, Sokhai Pathar, 08 March 1962, S.R. Rolla 77727 (BSI); Bhimashankar, 10 December 1956, J.A. Vasavada 4869 (BSI); Korai fort, Ambavane, 31 January 1964, B.V. Reddi 95832 (BSI); Korai fort, 30 March 1957, G.S. Pury 12587 (BSI); Khandala, Top of Bhama hill, 24 December 1962, S.R. Rolla 83448 (BSI); Koraikhilla Forest, 12 December 1963, B.V. Reddi 93304 (CAL); Lonavala, April 1961, A Meebold 4886 (CAL); s.l., 5 March 1962, S.R. Rolla 33077 (CAL); near sakarpathar, hill slopes, 24 April 1964, B.V. Reddi 101166 (BSI, CAL); Lohagadh, 05 May 1962, S.K. Jain 899 (BSI); near R. H. Amantwane Koraikhilla forest, 22 November 1963, B.V. Reddi 93304 (BSI); Top of Malvali hills, 06 March 1962, S.R. Rolla 77636 (BSI); Top of Durg Fort, 12 January 1965, K. Hemadri 104402 (BSI); Purandar, s.d., G.S. Perrottet (GZU000245994); s.d., V.V. Jacquemont 192 (GZU); 18 February 1963, S.R. Rolla 86533 (BSI); northern slope of Vandra Khurd, 01 December 1961, K.P. Janardhanan 76128 (BSI); near Vandra, Andheri, 30 November 1961, K.P. Jandhanan 76037 (BSI); southern slope of Shinga hill, 27 November 1961, K.P. Janardhanan 75894 (BSI); Butha Ka Dha, near Bhavgiri, 12 February 1961, K.P. Janardhanan 69105 (BSI); Foot of Shiva Hills, 11 December 1961, K.P. Janardhanan 76496

(BSI); Northern slope of Vihigaon Hills, 10 December 1961, *K.P. Janardhanan* 76430 (BSI); near Gadag, top of rasacha jungle, 05 December 1961, *K.P. Janardhanan* 76274 (BSI); Raigad district, Matheran, *s.d.*, *J. Cooke s.n.* (BSI); Dhobi lake, 01 March 1957, *S.K. Jain* 14084 (BSI); Ratnagiri district, Rajapur, 13 April 2017, *P.V. Deshmukh* 535 (SUK); Raipatan, 01 February 2017, *M.M. Lekhak* 520 (SUK); Sangli district, Shirala, 28 February 1996, *A.N. Londhe* 175377 (BSI); Satara district, Bamnoli, Vasota fort, 17 December 2001, *S.P. Gaikwad* 033 (SUK); Bhoma hill, 08 March 1962, *S.R. Rolla* 78872 (BSI); Lingmala falls, 29 November 1962, *A.S. Rao* 77984 (BSI); Mahabaleshwar, 05 January 1957, *S.D. Mahajan* 13978 (BSI); 27 December 1957, *Y.A. Merchant* 484 (BLAT); Near Singaroha temple, 21 March 1956, *S.K. Jain* 15 (BSI); near Arthur Point, 19 December 1963, *K.C. Kanodia* 87038 (BSI); Kaas Plateau, February 1995, *M.P. Bachulkar* 20428 (SUK); Sindhudurg District, Amboli, 16 February 2017, *P.V. Deshmukh* 525 (SUK); Rangana fort, 13 February 1970, *B.G. Kulkarni* 120094 (BSI); Thane District, Dhamni hill, 19 October 1967, *K.V. Billore* 112906 (CAL); Jun par Bassun, 26 November 1902, *G.A. Byan* 12 (BSI); Murabad range, Sidhagad, 12 April 1968, *K.V. Billore* 113877 (BSI, CAL); Tungar hill, mandvi range, 19 January 1968, *K.V. Billore* 113667 (CAL); Yavatmal District, Kharbi, bank of penganga river, 13 February 1977, *S. Karthikeyan* 149043 (BSI). RAJASTHAN: Sirohi district, Aravalli Range, Mount Abu, 14 April 1960, *S.K. Jain* 62074 (BSI); Mt. Abu 4000 ft., 31 July 1956, *S.K. Jain* 5435 (BSI). TAMILNADU: Neelgherries [Nilgiri Mountains] *s.d.* *G.S. Perrottet* 131 (GZU).

Palynology

The comparison of pollen characters of all the studied taxa is depicted in Table 1 and Figure 9.

TABLE 1. Palynological parameters of *Haplanthodes*

| Taxa | Short axis (P) (µm) | Long axis (E) (µm) | P/E ratio | Pollen shape | Ornamentation |
|---|---------------------|--------------------|-----------|--------------------|---------------|
| <i>H. neilgherryensis</i> var. <i>neilgherryensis</i> | 33.07±0.64 | 31.20±0.60 | 1.05 | Oblate | reticulate |
| <i>H. plumosa</i> | 32.34±0.52 | 29.74±0.72 | 1.08 | Oblate | reticulate |
| <i>H. tentaculata</i> | 30.05±0.65 | 27.76±0.63 | 1.08 | Oblate | reticulate |
| <i>H. verticillata</i> | 32.80±0.78 | 30.16±0.88 | 1.08 | Prolate spheroidal | reticulate |
| <i>H. neilgherryensis</i> var. <i>toranganensis</i> | 29.64±0.75 | 28.39±0.79 | 1.04 | Oblate | reticulate |

1a. *H. neilgherryensis* var. *neilgherryensis*:—Pollen grains oblate, 27–38 × 27–33 µm; polar outline distinctly triangular; trizonocolporate, angulaperturate; colpi slightly bravicolporate, about 7 µm wide at equator; ora lalongate, clearly operculate, crassimarginate; opercula and colpi of the same size, surface clearly echinulate, bordered with thick and spinulate exine protruding towards colpal margin; mesocolpia about 24 µm long, apocolpia around 6 µm across; exine about 2 µm thick, tectate, reticulate; heterobrochate, muri 1 µm thick, simplibaculate; lumen polygonal, 1–3 µm across, decreasing in size towards colpal margin and apocolpia.

1b. *H. neilgherryensis* var. *toranganensis*:—Pollen grains oblate, 29–39 × 28–35 µm, polar outline distinctly triangular, trizonocolporate, angulaperturate; colpi slightly bravicolporate, about 6 µm wide at equator; ora lalongate, clearly operculate, crassimarginate; opercula and colpi of the same size, surface clearly echinulate, bordered with thick and spinulate exine protruding towards colpal margin; exine tectate, reticulate; lumen polygonal, 1–3 µm across, decreasing in size towards colpal margin and apocolpia.

2. *H. plumosa*:—Pollen grains oblate, 29–38 × 29–36 µm, polar outline distinctly triangular, trizonocolporate, angulaperturate; colpi slightly bravicolporate, about 8 µm wide at equator; ora lalongate, clearly operculate, crassimarginate; opercular margins thin, protruding, and studded with a single row of spinules that are decreasing in length towards colpal ends; exine tectate, homobrochate, lumen polygonal, uniform in size.

3. *H. tentaculata*:—Pollen grains oblate, 29–38 × 25–33 µm, polar outline distinctly triangular, trizonocolporate, angulaperturate; colpi distinctly bravicolporate, operculate, about 7 µm wide at equator; opercula covered with compactly placed and slightly bulbous spinules, crassimarginate, collared with spinules which are decreasing in size towards colpal ends; exine about 2 µm thick, tectate, slightly heterobrochate, simplibaculate, lumen polygonal, uniform in size.

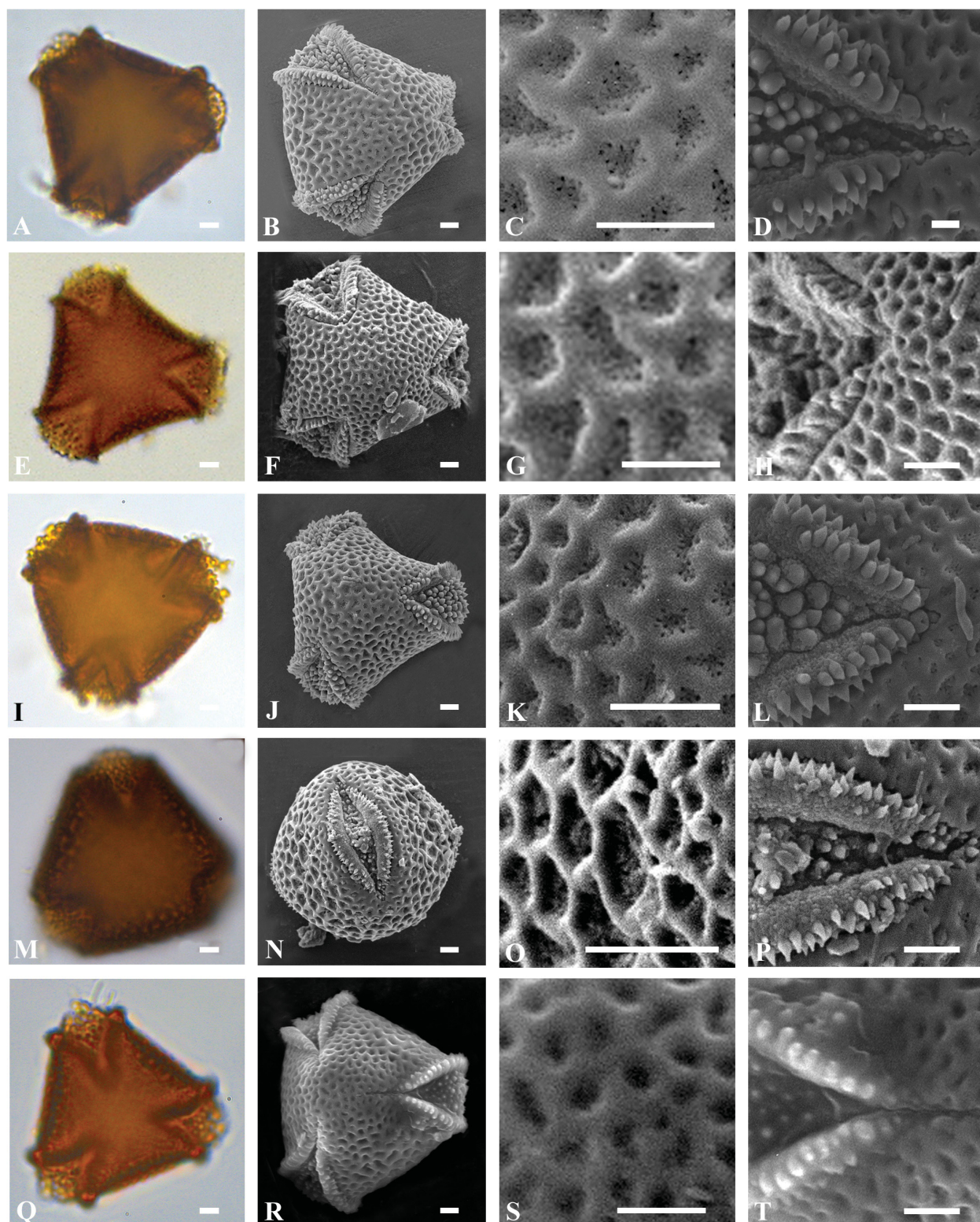


FIGURE 9. Light microscopic and scanning electron photomicrographs of *Haplanthodes* pollens. *H. neilgherryensis* var. *neilgherryensis*. A-B. polar view showing triangular outline, C. detail of reticulum in polar view, D. colpus. *H. plumosa*. E-F. polar view showing triangular outline, G. detail of reticulum in polar view, H. colpus. *H. tentaculata*. I-J. polar view showing triangular outline, K. detail of reticulum in polar view, L. colpus. *H. verticillata*. M. polar view showing triangular outline, N. equatorial view showing colpus, O. detail of reticulum in polar view, P. colpus. *Haplanthodes neilgherryensis* var. *toranganensis* Q-R. polar view showing triangular outline, S. detail of reticulum in polar view, T. colpus. Scale bars = 2 μ m

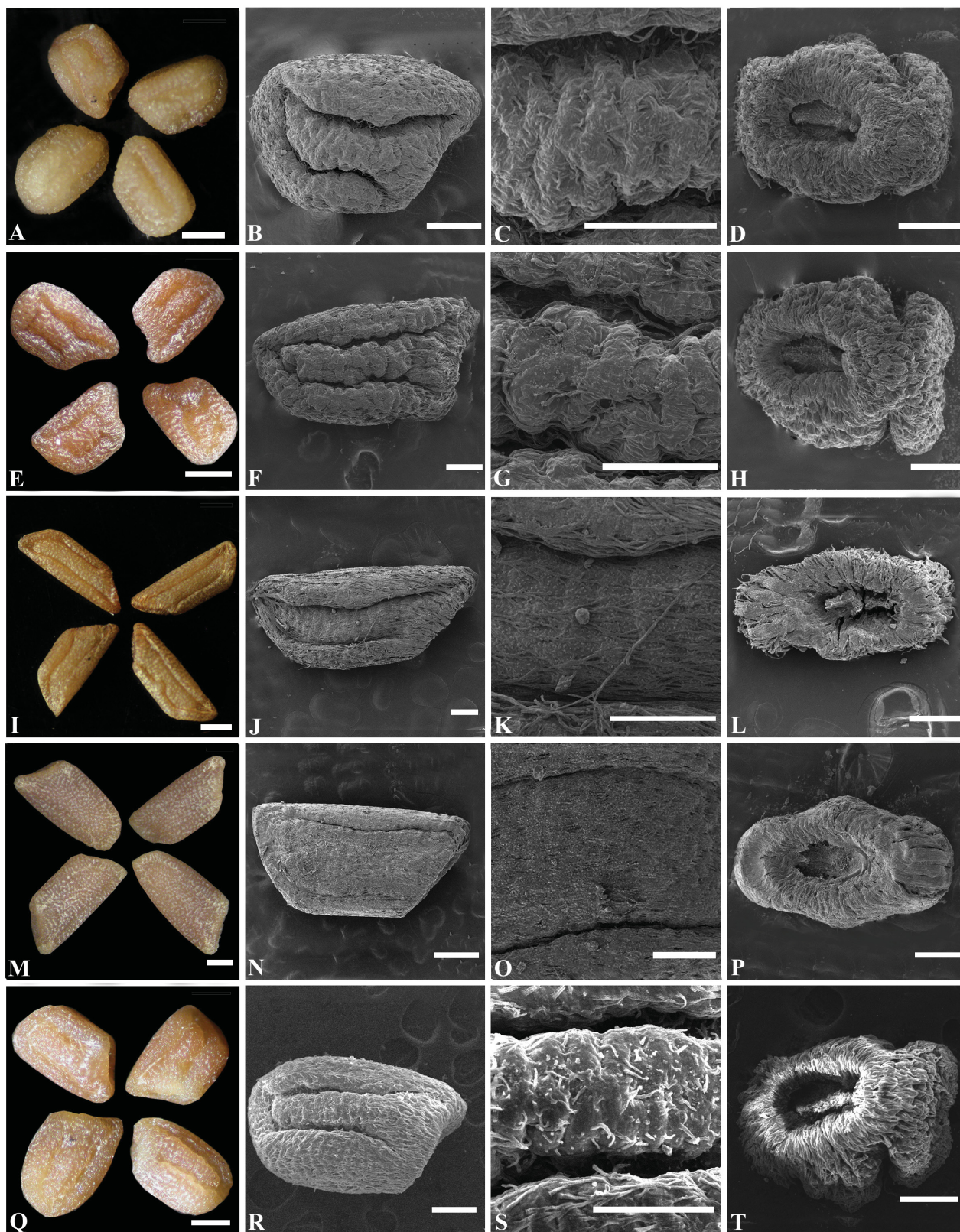


FIGURE 10. Light microscopic and scanning electron photomicrographs of *Haplanthodes* seeds. *H. neilgherryensis* var. *neilgherryensis*. A. seeds under light microscope, B. seed with U-shaped groove, C. grooved portion enlarged to show testa cells, D. hilum. *H. plumosa*. E. seeds under light microscope, F. seed with U-shaped groove, G. grooved portion enlarged to show testa cells, H. hilum. *H. tentaculata*. I. seeds under light microscope, J. seed with U-shaped groove, K. grooved portion enlarged to show testa cells, L. hilum. *H. verticillata*. M. seeds under light microscope, N. seed with U-shaped groove, O. grooved portion enlarged to show testa cells, P. hilum. *H. neilgherryensis* var. *toranganensis*. Q. seeds under light microscope, R. seed with U-shaped groove, S. grooved portion enlarged to show testa cells, T. hilum. Scale bars = 500 μ m for light microscopic and 200 μ m for scanning electron photomicrographs.

4. *H. verticillata*:—Pollen grains prolate spheroidal, $29\text{--}38 \times 25\text{--}36\ \mu\text{m}$, distinctly tricolporate, bravicolate; opercula sparsely spinulate, distinctly collared with protruding exine bordered with bulbous spinules; exine about $2\ \mu\text{m}$ thick, tectate, lumen psilate, muri rounded polygonal, simplibaculate, heterobrochate, distinctly large in mesocolpal area and decreasing in size toward polar areas and colpal margins.

Seed micromorphology

The comparative account of seed micromorphology of all the studied taxa is summarized in Table 2 and Figure 10.

1a. *H. neilgherryensis* var. *neilgherryensis*:—Oblong-ellipsoid, $0.8\text{--}1.1 \times 0.5\text{--}0.7\ \text{mm}$, brownish; surface sparsely hygroscopic, reticulate, densely strigose hairy, deeply compressed at base, elliptic at apex, distinctly tuberculate U-shaped grooves on both side surfaces; periclinal wall distinctly convex shaped; anticlinal wall undulate; epidermal cells irregular, polygonal, undulate, $0.068 \times 0.063\ \text{mm}$; hilum deeply grooved, elliptic with central elevation, $0.21 \times 0.06\ \text{mm}$.

TABLE 2. Micromorphological parameters of seeds of *Haplanthodes*

| Characters | <i>H. neilgherryensis</i> var. <i>neilgherryensis</i> | <i>H. neilgherryensis</i> var. <i>toranganensis</i> | <i>H. plumosa</i> | <i>H. tentaculata</i> | <i>H. verticillata</i> |
|---------------------------|---|---|---|---|---|
| Shape | Oblong-ellipsoid, base deeply compressed, apex elliptic | Oblong-ellipsoid, base deeply compressed, apex elliptic | Ellipsoid, base deeply compressed, apex elliptic | Ellipsoid, base slightly compressed, apex oblong | Ellipsoid, base slightly compressed, apex oblong |
| Size (L×B) (mm) | $0.8\text{--}1.1 \times 0.5\text{--}0.7$ | $1\text{--}1.25 \times 0.7\text{--}1.0$ | $0.5\text{--}1.0 \times 0.7\text{--}0.9$ | $1.5\text{--}2 \times 0.4\text{--}0.6$ | $2.0\text{--}2.5 \times 1.0\text{--}1.5$ |
| Surface | Strigose, distinctly tuberculate, U-shaped groove present | Strigose, distinctly tuberculate, U-shaped groove present | Strigulose, distinctly tuberculate U-shaped groove present | Strigulose, slightly depressed, U-shaped groove present | Strigulose, slightly depressed, U-shaped groove present |
| Ornamentation | Reticulate | Reticulate | Reticulate | Micro-papillate | Reticulate |
| Epidermal cell (L×B) (mm) | Irregular, polygonal, undulate, 0.068×0.063 | Irregular, polygonal, undulate, 0.05×0.04 | Irregular, elongated in one direction, undulate, 0.15×0.05 | Inconspicuous, irregular, slightly undulate, 0.10×0.08 | Inconspicuous, irregular, slightly undulate, 0.08×0.05 |
| Hilum (L×B) (mm) | Deeply grooved, elliptic, 0.21×0.06 | Deeply grooved, elliptic, 0.20×0.08 | Deeply grooved, elliptic, 0.18×0.08 | Shallowly grooved, elliptic, 0.29×0.08 | Shallowly grooved, elliptic, 0.20×0.12 |

1b. *H. neilgherryensis* var. *toranganensis*:—Oblong-ellipsoid, $1\text{--}1.25 \times 0.7\text{--}1.0\ \text{mm}$, brownish; surface densely hygroscopic, reticulate, strigose, deeply compressed at base, elliptic at apex, distinctly tuberculate U-shaped groove on both side surfaces; periclinal wall distinctly convex shaped; anticlinal wall undulate; epidermal cells irregular, polygonal, undulate, $0.05 \times 0.04\ \text{mm}$; hilum deeply grooved, elliptic with central elevation, $0.20 \times 0.08\ \text{mm}$.

2. *H. plumosa*:—Ellipsoid, $0.5\text{--}1.0 \times 0.7\text{--}0.9\ \text{mm}$, brownish; surface hygroscopic, reticulate, densely strigulose, deeply compressed at base, elliptic at apex, distinctly tuberculate U-shaped groove on both side surfaces; periclinal wall distinctly convex shaped; anticlinal wall undulate; epidermal cells irregular, elongated in one direction, undulate, $0.15 \times 0.05\ \text{mm}$; hilum deeply grooved, elliptic with central elevation, $0.18 \times 0.08\ \text{mm}$.

3. *H. tentaculata*:—Ellipsoid, $1.5\text{--}2 \times 0.4\text{--}0.6\ \text{mm}$, brownish; surface hygroscopic, micro-papillate, strigulose hairy, slightly compressed at base, oblong at apex, slightly depressed U-shaped groove on both side surfaces; periclinal wall convex shaped; anticlinal wall undulate; epidermal cells inconspicuous, irregular, slightly undulate, 0.10×0.08 ; hilum shallowly grooved, elliptic with central elevation, $0.029 \times 0.08\ \text{mm}$.

4. *H. verticillata*:—Ellipsoid, 2–2.5×1–1.5 mm, brownish; surface hygroscopic, reticulate, sparsely strigulose hairy, slightly compressed at base, oblong at apex, slightly depressed U-shaped groove on both side surfaces; periclinal wall convex shaped; anticlinal wall slightly undulate; epidermal cells inconspicuous, irregular, slightly undulate, 0.08×0.05 mm; hilum shallowly grooved, elliptic with central elevation, 0.20×0.12 mm.

Discussion

The genus *Haplanthodes* now comprises five taxa including the new variety, i.e. *H. neilgherryensis* var. *toranganensis*. Morphological characters revealed that the cladodes in the inflorescence and the number of ovules per ovary can be used for generic delimitation. In *Haplanthodes*, cladodes are present in the inflorescence and each cell in the ovary has 3–4 ovules whereas *Andrographis* and *Haplanthus* lack cladodes and 6–8 ovules are present in each cell (Gnanasekaran *et al.* 2016). For infrageneric delimitation of *Haplanthodes*, different characters can be used such as structure, length, spines, hairiness and arrangement of cladodes, length of internodes and hairiness of ovary. Cladodes of *H. plumosa* are densely plumose hairy which is not the case in rest of the taxa. *H. tentaculata* possesses filiform, ending in two soft teeth cladodes, not arranged in a whorl whereas *H. verticillata* has very stout, ending in two hard spinous teeth cladodes arranged in a whorl. The newly described variety *H. neilgherryensis* var. *toranganensis* has 2 cm long cladode, lax internodes, ovary hairy throughout, seeds densely hygroscopic hairy whereas *H. neilgherryensis* var. *neilgherryensis* has 1 cm long cladode, compact internodes, ovary hairy at the upper half part and sparsely hygroscopic hairy seeds. Micromorphological characters of the seeds such as shape, surface ornamentation and shape of epidermal cells are of taxonomic value and can be used to delimit species. Based on surface sculpturing pattern, seeds of two types (reticulate and micro-papillate) were recognized for the first time. Micro-papillate surface ornamentation was found in *H. tentaculata* whereas the remaining taxa had reticulate surface ornamentation. *Haplanthodes* is related to *Andrographis* and *Haplanthus*. Gnanasekaran *et al.* (2016) compared the pollen and seed morphology of *Andrographis*, *Haplanthus* and *Haplanthodes*. Pollen grains of *Andrographis* are prolate or subprolate whereas in *Haplanthus* pollen grains are oblate. The shape of pollen grains of *Haplanthodes* ranges from oblate to prolate spheroidal with the latter condition found in case of *H. verticillata* only. Overall, the pollen morphology (shape, size, ornamentation, colpi and polar outline) is uniform among the *Haplanthodes* taxa. *Haplanthodes* is more close to *Haplanthus* in terms of pollen morphology. Scotland (1992) studied the pollen morphology of Andrographideae and concluded that the monophyly of the tribe Andrographideae is supported by pollen morphology. The pollen grains are triaperturate apertures and thickened exine. Scotland (1992) studied two species of *Haplanthodes*, *H. tentaculata* and *H. verticillata* under *Haplanthus*, and noted that pollen character are congruent for *Haplanthus* (*Haplanthodes* actually) and *Andrographis*. Our studies on *Haplanthodes* also reveal triaperturate and triangular nature of pollen grains.

Seeds of *Haplanthodes* are hygroscopic hairy whereas *Andrographis* and *Haplanthus* possess glabrous seeds. The seeds are distinctly grooved in *Andrographis* and *Haplanthodes* whereas the groove is shallow/not distinct in *Haplanthus*. Comprehensive studies on seed micromorphology in Andrographideae are lacking. Pollen and seed characters may not be sufficient to understand the interrelationships among these genera. Also, the studies by McDade *et al.* (2008) revealed that Andrographideae are monophyletic and sister to Barlerieae, however, their sampling did not include *Haplanthus* and *Haplanthodes*. Hence, it would be worth to attempt phylogenetic studies encompassing sufficient samples of *Andrographis*, *Haplanthus* and *Haplanthodes*.

Acknowledgements

The authors are grateful to the Head, Department of Botany, Shivaji University, Kolhapur for providing research facilities. We also thank the authorities of BLAT, BSI, CAL, MH and SUK for allowing us to consult herbarium specimens. Thanks are also due to the authorities of DC, GZU, K, L, LINN, P & U for allowing us to consult herbarium specimens online. We acknowledge Dr. Mayur Nandikar, Scientist, NGCPR and Mr. Danish Husain, CIMAP, Lucknow for their comments and suggestions on the manuscript.

References

- Anderson, T. (1867) An Enumeration of the Indian Species of Acanthaceae. *Journal of Linnaean Society Botany* 9: 425–526.
<https://doi.org/10.1111/j.1095-8339.1867.tb01308.x>
- Barthlott, W. (1981) Epidermal seed surface characters of plants: Systematic applicability and some evolutionary aspects. *Nordic Journal of Botany* 1: 345–355.
<https://doi.org/10.1111/j.1756-1051.1981.tb00704.x>
- Bentham, G. & Hooker, J.D. (1876) *Genera Plantarum* 2. Reeve & Co., London, pp. 533–1226.
- Clarke, C.B. (1885) Acanthaceae. In: Hooker, J.D. (ed.) *The Flora of British India* 4. L. Reeve & Co., London, pp. 387–558.
- Cooke, T. (1908) *The Flora of the Presidency of Bombay*. Taylor & Francis, London, 375 pp.
- Erdtman, G. (1960) The Acetolysis Method - a revised description. *Svensk Botanisk Tidskrift* 54: 561–564.
- Forman, L.L. (1989) The illustrations to William Hunter's 'Plants of Wales Island'. *Kew Bulletin* 44 (1): 151–161.
<https://doi.org/10.2307/4114655>
- Gnanasekaran, G., Murthy, G.V.S. & Deng, Y.F. (2016) Resurrection of the genus *Haplanthus* (Acanthaceae: Andrographinae). *Blumea* 61: 165–169.
<https://doi.org/10.3767/000651916X693185>
- Hijmans, R.J., Guarino, L., Cruz, M. & Rojas, E. (2001) Computer tools for spatial analysis of plant genetic resources data: 1. DIVA-GIS. *Plant Genetics Resources Newsletter* 127: 15–19.
- Imlay, J.B. (1939) Contribution to the Flora of Siam. *Bulletin of Miscellaneous Information. Royal Botanic Gardens, Kew* 3: 109–150.
<https://doi.org/10.2307/4111677>
- Kuntze, O. (1903) *Lexicon generum phanarogamarum*. Deutsche verlags-anstalt, Stuttgart, pp. 1–709.
- Jarvis, C. (2007) *Order out of Chaos: Linnaean plant names and their types*. The Linnaean Society of London in Association with the Natural History Museum, London, pp. 247–936.
- Linnaeus, C. (1756) *Centuria II Plantarum*. L.M. Hojer, Uppsala, pp. 1–34.
- Majumdar, R.B. (1971) Notes on Rajasthan flora III. *Bulletin of the Botanical Society of Bengal* 25: 75–76.
- McDade, L.A., Daniel, T.F. & Kiel, C. A. (2008) Toward a comprehensive understanding of phylogenetic relationships among lineages of Acanthaceae s.l. (Lamiales). *American Journal of Botany* 95: 1136–1152.
<https://doi.org/10.3732/ajb.0800096>
- Nees, (1832) Acanthaceae Indiae Orientalis. In: Wallich, N. (Ed.) *Plantae Asiaticae rariores, or, Descriptions and figures of a select number of unpublished East Indian plants* 3. Treuttel et Wurtz, London, pp. 77–117.
- Nees, (1847) Acanthaceae. In: Candolle, A.P. de. (Ed.) *Prodromus Systematis Naturalis Regni Vegetabilis* 11. Treuttel et Wurtz, Paris, pp. 46–519.
- Panigrahi, G. & Das, G.C. (1981) A revision of *Haplanthodes* O. Kuntze (Acanthaceae). *Bulletin of the Botanical Survey of India* 23: 197–203.
- Punt, W., Blackmore, S., Nilsson, S. & Thomas, A. (1994) *Glossary of pollen and spore terminology*. Utrecht, LPP Foundation, pp. 7–71.
- Roth, A.W. (1821) *Novae Plantarum Species praesertim Indiae Orientalis*. Halberstadii: Sumptibus H. Vogleri, pp. 1–400.
- Roxburgh, W. (1820) *Flora Indica; or descriptions of Indian Plants I*. Thacker & Co., Serampore, pp. 1–720.
- Scotland, R.W. (1992) Pollen morphology of Andrographideae (Acanthaceae). *Review of Palaeobotany and Palynology* 72: 229–243.
[https://doi.org/10.1016/0034-6667\(92\)90028-F](https://doi.org/10.1016/0034-6667(92)90028-F)
- Singh, N.P., Lakshminarasimhan, P., Karthikeyan, S., & Prasanna, P.V. (2001) *Flora of Maharashtra State 2. Dicotyledons*. Botanical Survey of India, Calcutta, pp. 589–684.
- Surveswaran, S., Tiwari, N., Karanth, P.K., Deshmukh, P.V. & Lekhak, M.M. (November 9, 2020.) Molecular phylogenetics and character evolution in *Haplanthodes* (Acanthaceae), an endemic genus from peninsular India. *bioRxiv*.
<https://doi.org/10.1101/2020.11.08.373605>
- Thiers, B. (2020) *Index Herbariorum: a global directory of public herbaria and associated staff*. New York Botanical Garden's Virtual Herbarium. [<http://sweetgum.nybg.org/science/ih/>]
- Turland, N.J., Wiersema, J.H., Barrie, F.R., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Kusber, W.-H., Li, D.-Z., Marhold, K., May, T.W., McNeill, J., Monro, A.M., Prado, J., Price, M.J. & Smith, G.F. (2018) *International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017*. [Regnum Vegetabile 159]. Koeltz Botanical Books, Glashütten.
<https://doi.org/10.12705/Code.2018>
- Turner, I.M. (2021) Heyne, Roth, Roemer and Schultes, and the plant names published in *Novae plantarum species praesertim Indiae*

orientalis. *Taxon* 70 (2): 365–428.

<https://doi.org/10.1002/tax.12449>

Wight, R. (1850) *Icones plantarum Indiae Orientalis: or figures of Indian plants*. 4. J.B. Pharoah, Madras, pp. 1–1621.

Wood, J.R.I. (2014) New names and combinations in Indian Acanthaceae. *Novon: A Journal of Botanical Nomenclature* 23 (3): 385–395.

<https://doi.org/10.3417/2013046>